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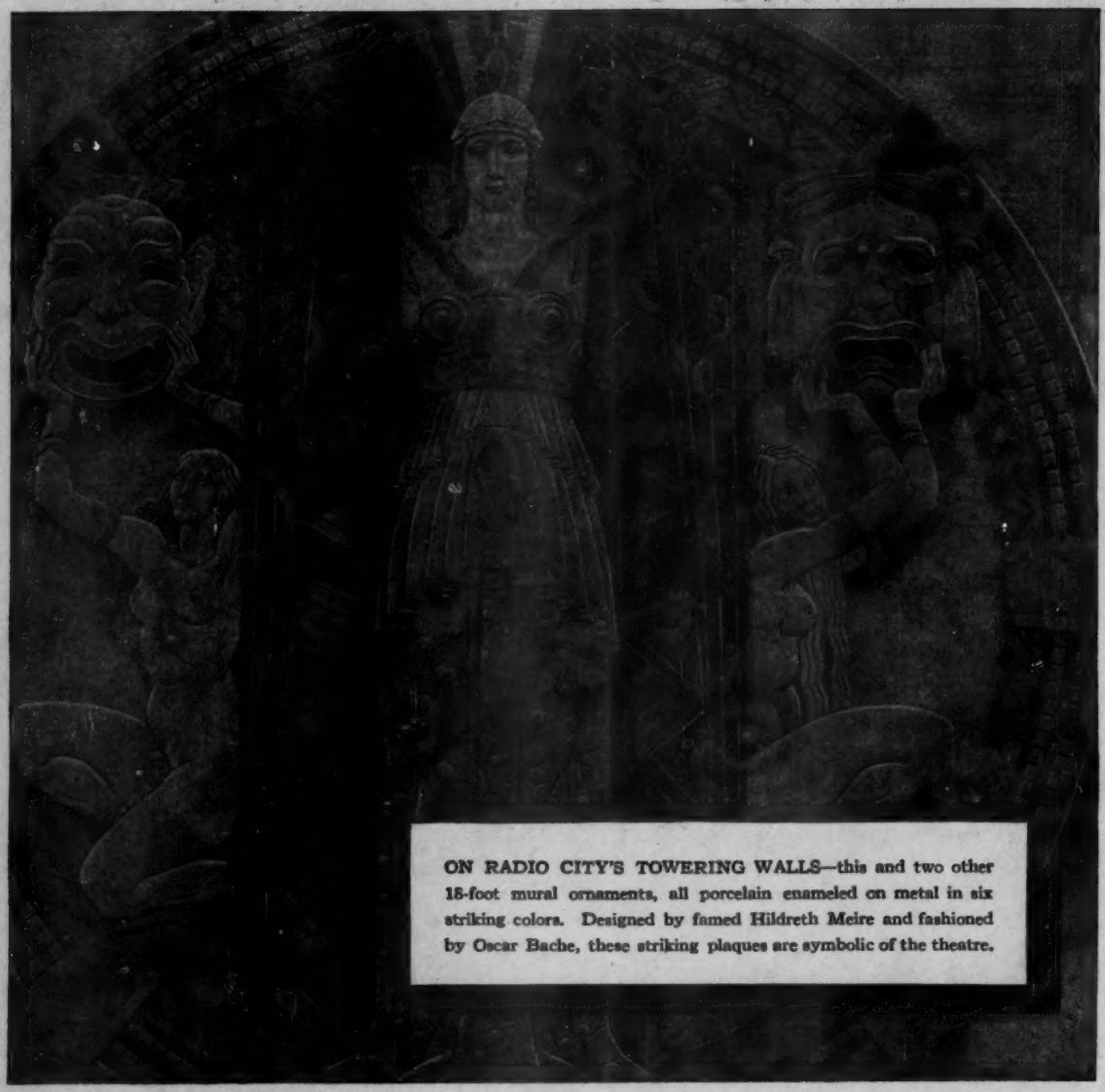
OF THE
AMERICAN CERAMIC SOCIETY

A MONTHLY PUBLICATION DEVOTED
TO THE PROMOTION OF CERAMIC
EDUCATION AND TECHNOLOGY

APRIL • 1934

VOLUME 13 NUMBER 4



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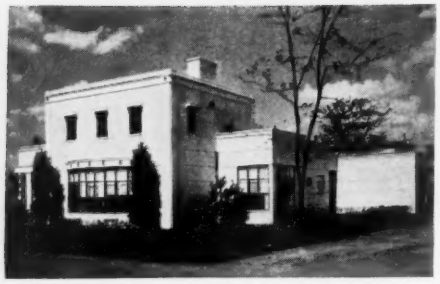

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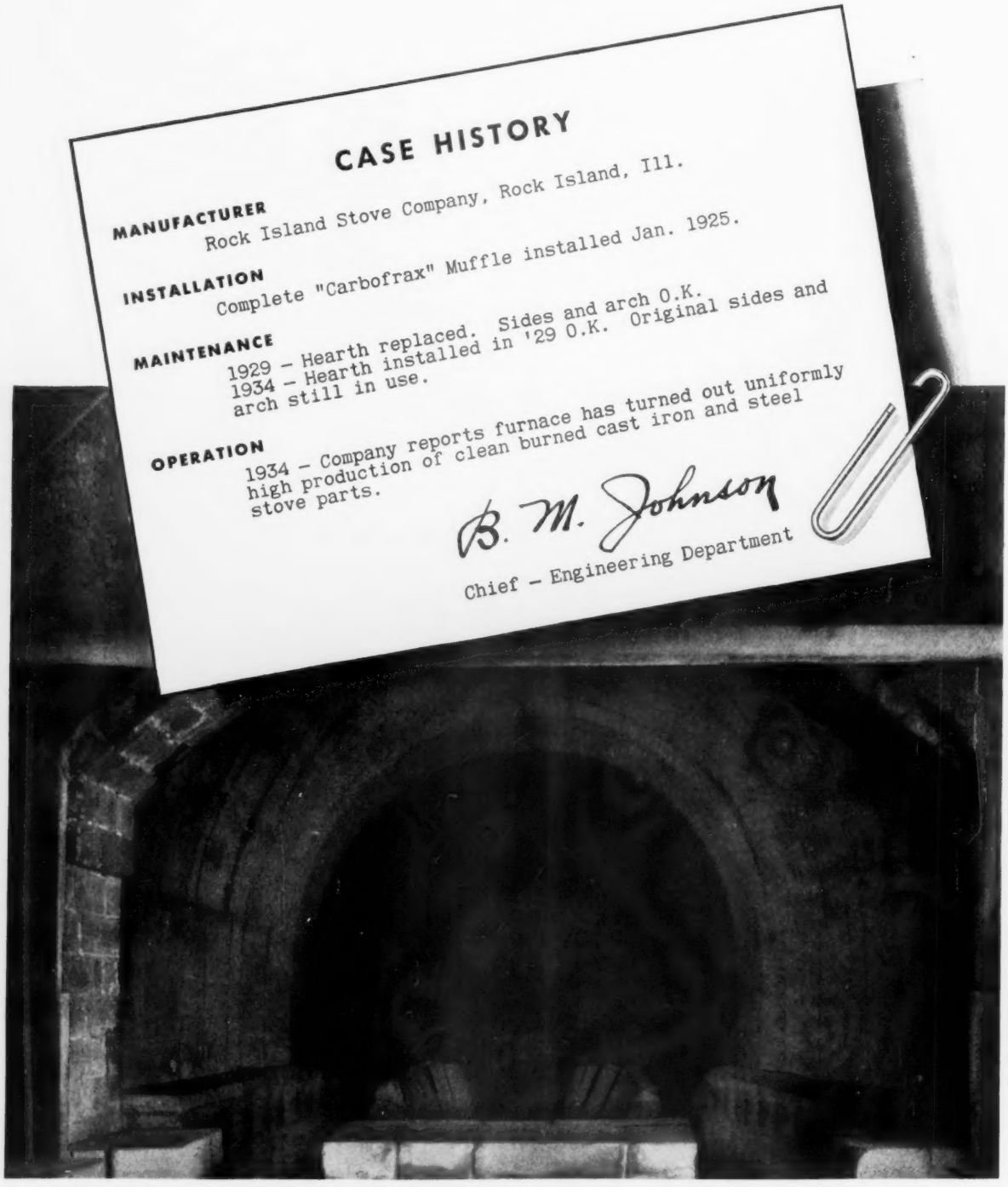
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THE BULLETIN

of the American Ceramic Society

A Monthly Publication Devoted to Proceedings
of the Society and Promotion of Coöperative Research
of Technical, Scientific, and Art Questions

Vol. 13 April, 1934 No. 4

EDITORIALS

CERAMIC EDUCATION

Fourth Editorial in Honor of the Fortieth Anniversary of the Founding of the First Collegiate School of Ceramics in America

By Ross C. Purdy

The survey made in the first three of this series of editorials developed the following facts: (1) That graduates of ceramic schools are not taking as large a proportionate part in the leadership and activities of the American Ceramic Society as they did in earlier years. (2) That men trained in sciences of chemistry, physics, and geology (not necessarily post-graduates), are to an increasing extent taking from graduates of our ceramic schools the leadership in ceramic research and in industrial management. (3) That our ceramic schools have given in the past and are now giving men what today is high-grade trade school training for jobs as technologists. (4) That there should be a ceramic school in every state in which ceramics is of industrial importance. (5) That there need be no worry about ceramic schools graduating more men than the industries can absorb. (6) That the graduate of a ceramic school would be unfaithful to himself, his parents, his dependents, and his commonwealth if he does not pursue his studies as systematically while industrially employed as he did in college.

The theme of the previous editorials has been that the four-year ceramic school curricula should provide for (1) a more thorough training in mathematics, chemistry, physics, mineralogy, and geology; (2) that less time in the four-year undergraduate curricula should be given to actual ceramic courses; and (3) that the ceramic lectures and laboratory work should be devoted to the study of ceramic products, their properties, composition, constitution, and methods of production using science facts and facts developed by experience to measure and explain the character of the resultant products.

The 1934 Report of the Committee on Education[1] substantiates most of the recommendations which have been made in this editorial series, disputing in no particular and confirming nearly every proposal made. Reports of the Committee on Education under the chairmanship of Homer F. Staley and also of W. Keith McAfee contained recommendations which these editorials have presented. These editorials are also in line with the recommendations which industrial managers made at the 1933 Meeting.[2]

Can it be that the data presented in these editorials are what are provoking the university ceramic instructors to protest at this time? If so, should not the university instructors, if possible, interpret these data favorably in their present-day curricula?

The editorial on ceramic education which appeared in the March issue of *Ceramic Industry* does the writer an injustice in styling as "implications" what in reality are only that editor's interpretations of the published statements, some

Editor's Note: This year being the fortieth anniversary of the founding of collegiate ceramic education in the United States, the theme of the 1934 editorials will be ceramic education. Since the points raised and the opinions expressed will be controversial in character these editorials will be signed, thus showing that the views stated have not previously been submitted for approval to the Board of Trustees, the Publications Committee, or the Committee on Education. The pages of *The Bulletin* are open to any one who cares to register his views on ceramic education. Communications received will be published without being censored.

Reference is also made to editorials on this subject appearing in consecutive issues of *The Bulletin* since November, 1933.

[1] See *The Bulletin*, March, pp. 69–71.

[2] See *The Bulletin* for November, pp. 319–24, 1933, "Ceramic Education Symposium."

of which interpretations are grossly wrong. That the writer's ideas may not be misunderstood the following statement is made: (1) that curricula of our ceramic schools are behind the advancements which have been made largely by the schools themselves in science, fundamental and applied, applicable to ceramics; (2) that the graduates are not for the most part equipped as well as they should be to meet the needs of the ceramic industries; and (3) that some of the lecture and laboratory courses given supposedly to teach ceramic technology are a waste of time, effort, and money.

These statements concern the inadequacy of the present ceramic curricula. They are not to be misinterpreted to mean any of the things the editor of *Ceramic Industry* chose to style "implications." I imply nothing. I mean only what I state and lest I be misunderstood let me reiterate that our ceramic school graduates are serving the ceramic industries fairly well, that there should be a ceramic school in each state in which ceramic industries are of economic importance, and that there need be no worry about the number who may be graduated by our schools—but the study curricula need revamping in keeping with the science advancements made and with the large amount of information now published.

The difficulty in evaluating given ceramic curricula is that some of the graduates of each are of such mentality and talent as to render industrial service and to take part in the affairs of the American Ceramic Society far beyond the possibilities and inclinations of most of the ceramic graduates. Some of these notable exceptions to the run of graduates have taken as electives or as extra curricula work more of the general sciences than is prescribed in the curricula.

Definite Recommendations

Seven definite recommendations made by the writer are as follows:

(1) That no ceramic instructor teach English, mathematics, chemistry, physics, geology, mineralogy, or any elementary subject. That all instruction other than strictly ceramic subjects be taught in departments the staffs of which are experts in their particular subjects.

(2) That such ceramic lecture courses as (*a*) clay occurrence and properties, (*b*) winning, preparation, and forming, (*c*) bodies, glazes, and colors, and (*d*) ceramic calculation be abolished.

(3) That plant trips be substituted for lecture courses on factory processes and equipment.

(4) That studies of commercial products be substituted for the usual laboratory courses in body, glaze, and color making.

(5) That the scientific studies of drying and firing include the physics, mathematics, and thermodynamics which apply and the equipment design required to obtain the most effective results.

(6) That ceramic curricula shall be designed to equip the graduate to continue his studies rather than merely to obtain a job, it being evident that ability to hold a job depends more upon what the man studiously develops than upon specific ceramic facts he learned in lecture or laboratory courses at school.

(7) That the report of the 1933–34 Committee on Education be given careful study and its recommendations adopted.

THE BIRTH OF THE AMERICAN CERAMIC SOCIETY*

By H. A. Wheeler

The old saying that "it is an ill wind that blows no good" has certainly been exemplified in the birth of our Society. For at the Pittsburgh meeting in February, 1898, of the National Brick Manufacturers Association (N.B.M.A.), a student of Professor Orton's pioneer ceramic school read a paper on glazing of terra cotta. It was a paper of decided technical merit but as the audience consisted mainly of brickmakers and machinery manufacturers it was a dud, or fell flat. Subsequently when the few technical members held a consolation meeting to discuss the discouraging reception of this paper, a suggestion was made by Sam Geijsbeek that the technical members form a club for presenting similar

* This response was made by Mr. Wheeler, first President of the American Ceramic Society, at the Annual Meeting of the Society in Cincinnati, February 13, 1934, following the presentation of Life Membership Certificates to the living Charter Members. See also the March issue of *The Bulletin*, p. 63. Received March 2, 1934.

high-grade papers. This idea strongly appealed to Professor Orton, who was the leading technician of the Association, and before the meeting adjourned, ten members met and decided to form an organization for the presenting of technical ceramic papers.

During the following years, the germ rapidly developed in Professor Orton's fertile brain, who by correspondence, finally issued an invitation to twenty-one other ceramists to meet at Columbus in February, 1899, with the N.B.M.A. to organize the American Ceramic Society.

Of the twenty-two charter members, seventeen met at the Southern Hotel at Columbus, Ohio, with the National Brick Manufacturers Association, in February, 1899, where the Society was born as the result of an unappreciated paper presented at the previous meeting. The energetic, diplomatic Secretary of the N.B.M.A., Theodore A. Randall, did his utmost to have the infant become a technical section of the brickmaker's organization, which had about four hundred members and consequently could get special rates from the railroads, but the "secessionists" were obdurate and insisted on an independent organization (most of the ceramic pioneers were members of the N.B.M.A.).

The week spent at the initial Columbus meeting was memorable for furnishing the solid foundation on which the Society has since flourished for thirty-five years. The keynote was sounded and deeply impressed by Professor Orton that quality, progress, and a scientific basis should be the objective of the Society; that secretiveness, which in the past had characterized and had been the stumbling block of the ceramic industry, should give way to liberal, scientific discussions; that the potter, who had learned his mixtures and glazes as confidential heirlooms, should be educated to appreciate that he would gain, rather than lose, by broad-minded, open discussions; and that the meeting and exchange of experiences of many technical minds meant progress.

When the election of officers came up at the first session, fearing that Orton's friends would nominate him for the transient presidency, I promptly arose and nominated him for Secretary, which is the vital office that assures the success of any organization. He was unanimously elected and the subsequent success of the Society was largely due to his untiring, able, judicious efforts during the twenty years he occupied the office until called to Washington by the World War.

With the enthusiasm of youth and an audience that appreciated technical papers, the Society waxed strong in its contributions to ceramics—if at first not in numbers—from a desire to insist on high standards for active membership. The animated discussions, freely indulged in by many members, often brought out greater results than the carefully prepared paper that originated it. We hoped to build the membership to about one hundred and a few optimists dreamed of two hundred, so the present roster of about two thousand members calls for a startling stretch of the imagination by the few Charter members that are still with us, or ten out of the original twenty-two. Six of the "old-timers" attended the 1934 Meeting: A. V. Bleininger, Karl Langenbeck, Ellis Lovejoy, W. D. Richardson, Heinrich Ries, and H. A. Wheeler. Of the four absentees, C. F. Binns was prevented by sickness from being there, while Samuel Geijsbeek was unable to make the long journey from his home on the Pacific Coast. The advanced age and poor health of Stanley G. Burt and W. D. Gates may prevent their future attendance, but their hearty enthusiasm and many past contributions assures their presence in spirit, if not in person.

The most beautiful rose has its thorn and one of the penalties of the unanticipated growth of the Society is the loss of "Section Q." For at the outset, when there was a warm, cordial intimacy among all the members, we would hold uncatalogued sessions in some quiet rathskeller and, with corncob pipes and a stein of beer, would hold informal, enthusiastic meetings, where intimate experiences could be safely exchanged that our employers would not permit in open sessions. Stanley Burt, the able technician of the Rookwood Pottery, the pride of American ceramics, was a leading spirit in the camaraderie of "Section Q," where the formality of Professor Orton was notably absent.

When the Society was formed, ceramic literature of a technical character was conspicuous by its absence in the English language. Professor Cook, as state geologist, had written his classic work on the New Jersey fire clays, but beyond being a generous compilation of chemical analyses, it gave no interpretation or discussion of the results. Professor Orton, in 1884, wrote a brief report on the Ohio clays and low-grade clay

industries. In 1896, the report on the Missouri clays by the writer was published, in which appeared for the first time in English a technical discussion of the physical and chemical properties of clays (besides descriptions of the clay deposits and industries of Missouri); while long out of print, it proved a useful work to the early ceramic schools.

There were many valuable ceramic contributions by the Germans, but most American ceramists were unable to translate them. Of monumental importance were the Seger contributions which our Society published in English after being laboriously translated by a special committee. Had our Society no other accomplishments, its life would not have been in vain for making this masterly work available to English readers.

With the invaluable background of the publications of the Society; with the large number of technical graduates from our fourteen ceramic schools; and with our large membership of active workers, may the anniversary of our Society thirty-five years hence show greater progress in the advancement of the ceramic industry than has occurred since the first meeting at Columbus in 1899. Although the National Brick Manufacturers Association greatly benefited and stimulated its members, it passed out of existence with the advancing age and subsequent death of its energetic secretary, Ted Randall, but it was the father of the infant that developed into the present robust, ambitious American Ceramic Society.

LOOKING AHEAD

Competition has always been experienced. Its nature changes. Competition between firms making like products lies today more in business management than in differences in product. Superiority in product is not as important a factor in meeting competition between producers of like products as is ability to meet specific requirements promptly and at lowest costs.

The keenest competition today is with products of different kinds made to serve the same purposes. Metals are today competing with ceramic structural materials. Organic compositions are serving purposes that once were served exclusively by ceramic products. Glass, glass enameled, and clay ware of all sorts are successfully competing. Competition does not, as it once did, hinge on superiority in service or appeal between products of like kind as much as it does on superiority of products of different materials designed to serve like purposes.

The modern competition of products of different compositions has brought technology into sales service. Development and promotion of manufactured products is now, much more than ever before, the task of the technical laboratories. The laboratories and technical staffs that are not constantly studying the product service demands as met by all sorts of products usable for the same purposes are not qualified to serve their employers constructively. Ceramists must be product service minded.

PAPERS AND DISCUSSIONS

NATURAL AND ARTIFICIAL CERAMIC PRODUCTS*

By Arthur L. Day†

Just as Shakespeare was moved to say that "All the world's a stage," so our philosophy leads to the thesis that all the world is a ceramic product.

It is not important for our discussion just how the earth was split off from the sun as a long wisp of gas, or whether the material thus separated afterward condensed to form our present earth or only some part of it, the remainder being supplied by additions from space during and after the condensation process. It is sufficient for our purpose to bear in mind that, whether the condensation took place in one operation or in a succession of them, our present earth must have passed through a liquid phase. Neither are we especially concerned whether or not the original gaseous mass, with or without subsequent additions, was homogeneous or not. It is again sufficient for our purpose to bear in mind that the elements comprising it possessed very different properties and affinities which must have exercised a determinative influence upon the process as soon as the condensation began. At least as early as this, therefore, some sort of segregation or regrouping must have commenced and must have continued both generally as the initial heat was lost and locally as chemical potential differences developed throughout the period during which the liquid phase was dominant.

If we were possessed of sufficient information regarding the properties of the participating elements at these earlier temperatures it might be possible in some fashion to picture the beginnings of association, but of these we have little knowledge and this for very limited temperature ranges which obviously are not the most critical for the early segregation processes. Gravity, of course, has been with us always and must have played an important, probably a predominant, rôle from the very beginning in determining the mass distribution within our planet.

Well-known facts seem to support this conclusion. The average density of the earth we know to be about 5.5 times that of water, while the density of the materials now comprising its accessible surface average only about one-half of that amount. From this it is possible to conclude without probability of serious error that the deep interior of the earth must somewhere attain to twice the average density or even higher. We know also, from laboratory experiment, extrapolated of course, that if the earth were entirely composed of the materials with which we are acquainted at the surface, that pressure alone could not reduce their bulk to a density of ten or more at the center. There is therefore immediate and tangible evidence that gravitational segregation began at an early stage and has probably continued throughout the condensation and solidification processes.

From the kind of information which seismologists obtain concerning the manner of transmission of elastic waves through the earth we may also infer with a high degree of probability that the density of the material beneath our feet does not increase uniformly to a maximum at the center, but that the outer structure bases upon a central core about which little is known except its dimensions, but which is often assumed to be of nickel steel partly because this is one of the substances of widest distribution throughout the earth and the meteorites which come to us from outside and partly because known properties of this material are of appropriate magnitude to serve as such a nucleus.

Seismologists tell us further that this nucleus is probably surrounded by a number of concentric shells, about which also little is known except that elastic waves, both longitudinal and transverse, travel with quite different speeds in passing through them and that fairly sharp boundaries are certainly indicated by reflection and refraction at the transition zones. Regarding the number of these shells and their thickness there is considerable difference of opinion among students of the subject in different countries. Three appear to be certainly indicated and most

* Presented as the second Edward Orton, Jr. Memorial Lecture, under the auspices of the Fellows, at the Annual Meeting, American Ceramic Society, Cincinnati, Ohio, February, 1934.

† Director, Geophysical Laboratory.

FIG. 1.—Vesuvius in 1906 (photo by Perret).

probably four or five, of which the outermost one forming the surface layer appears to be relatively thin, perhaps no more than 15 or 20 miles in thickness.

When first the fact became established that all of these shells transmit both longitudinal and transverse (shear) elastic vibrations it was concluded that here was proof that the earth was solid throughout. Later, however, this conclusion was modified by the fact that silicate solutions of extreme viscosity, such as would be found at depth under the load of overlying materials, will also permit transverse waves to pass, so that in the depths of the earth whether we choose to assume that the materials composing it are to be called liquid or solid, is of hardly more than academic interest. Daly in his latest analysis of the make-up of the interior of the earth finds it necessary to postulate properties belonging both to liquids and solids in order to account for the discontinuities in the development of the observed surface relationships and the symmetry of elastic wave transmission.

Certain it is that to the extent which we have been able to penetrate from the surface downward (about two miles) the temperature increases at a reasonably constant rate. If it is permissible to extrapolate this temperature gradient downward to any considerable distance, then we must presently arrive at a temperature when all known surface materials must be above their critical points and so of amorphous rather than crystalline structure. This conclusion necessitates a different appraisal of the forces of segregation from that which is concerned with the appearance of a crystalline phase, but our information here is too inadequate to venture upon any very definite hypothesis. It may be of passing interest in this connection to note that earthquakes are certainly recorded at the surface which have their origin from three to five hundred kilometers down, a region well within the zone where no crystalline phase would be expected. With our present knowledge of the properties of liquids of high viscosity it is extremely difficult to imagine sudden mechanical displacements in a continuous medium at this depth which could give rise to an earthquake at the surface of the solid and crystallized crust. We must therefore conclude that our knowledge of conditions even at this relatively short distance below the surface is wholly inadequate for more than the most speculative generalizations.

Of such isolated and inadequate facts and relationships is our present knowledge of the deep interior of the earth made up. It concerns us at the moment much more to consider the surface materials and how they come to be segregated as we now find them. Of course it is obvious from what has been said above that these surface materials are, generally speaking, the lightest of which the earth is made up. Their density averages about 2.7 when compared with water. They consist almost entirely of oxides which may also have been oxides in the liquid phase at the time when they separated in their present relations, for we are able very definitely to trace the steps through which some of the present surface compounds emerge out of groupings which must have existed in a prior stage of the condensation process. Indeed this effort to trace the formation process through which existing minerals and rocks come into being has formed the program of the Geophysical Laboratory for some thirty years, during which more than 800 papers have been published, and we have been by no means alone in this search.

The fact that the chief constituents of the rocks, the individual and mixed oxides determined by this cooling and segregation process, are precisely those materials which form the basis of modern ceramic products and the human relations which depend upon them, is perhaps the point which lends practical utility to this kind of investigation at the present time. The further fact that the rocks in their original formation process came down through slow temperature changes to their present condition following laws now well known to us lends fundamental logic and confidence to any effort to carry them back over the same route to earlier stages for the purpose of bringing out

particular combinations of them which today are found industrially useful. To the extent that we know the steps out of which the surface oxides of the rocks emerged from the liquid phase, to that extent at least we can proceed with certainty to a regrouping of the same materials in order to bring out artificial ceramic products with new or desired properties.

Perhaps I may illustrate most simply by saying that if we were intimately acquainted with the liquid phase from which given rocks formed, that phase could be very simply reproduced by taking the resulting rocks back over the same temperature route until the liquid phase was reached again. This would be sound logic and would yield a glass. If then this glass happened to have useful properties such as transparency and we could discover a process whereby the glass phase could be fixed at the temperatures of every-day life without losing this property, we should have attained to a useful ceramic product by merely reversing a natural process which preceded it. This is not quite the actual history of the development of useful ceramic products because it was hardly possible in those earliest days of primitive exploration to proceed with a background of well-ordered knowledge such as is today available; neither is it scientifically quite accurate because of the permanent loss out of the system of those volatile ingredients such as water which had an active share in determining the progress and character of the initial cooling process and crystallization, but it is nevertheless the logical point of departure of ceramic studies. Experience then quickly teaches us to select those particular oxides or groups of them which when returned to the higher temperatures will yield a glass with desirable properties and then so to control the final cooling as to prevent the identical segregation which produced the rocks and to substitute another. Thus by merely controlling the cooling rate may we preserve for use at ordinary temperatures properties which characterized the liquid phase or some phase relation found at temperatures lower down and which, for the purposes of society, are useful.

This logical procedure might be expressed in other terms as a melting process and an optimum upper temperature to restore homogeneity, followed by a controlled cooling process in the course of which certain desired properties may be fixed. The desired properties in the resulting glass are

FIG. 2.—Obsidian Cliff, Yellowstone Park (photo by Haynes).

sufficiently easy to define, but neither logical procedure nor experience would avail us much but for a single and most fortunate property of one of the ingredients (silica) which is probably responsible for most of the usefulness which glass finds in the arts of today, namely, the ability to bring it back, in large or small masses, to ordinary temperatures without recrystallization, and with a degree of stability amounting to permanence. Hence it follows that silica is the chief ingredient of all of our useful glasses and the glasses stand in the forefront among the artificial ceramic products. Indeed this remarkable property of silica which permits us to perpetuate at ordinary temperatures those properties which in most other materials are characteristic of the liquid phase lies at the base of much of the ceramic industry. Not only does this property of silica, either alone or in a wide range of mixtures, yield a mechanically stable product remarkably resistant to the attack of water or of acids and alkalis, but it provides a long range of temperature within which its viscosity is such that it can be conveniently worked into forms suggested by its various industrial uses. Moreover this convenient temperature zone in such mixtures is nearly a thousand degrees below the melting points of the refractory individual ingredients, a fact of vital importance for which physical chemistry has supplied sound reasons.

The same kind of analysis applied to brick or refractories brings out the same facts in somewhat different relation. Here strength and resistance to mechanical impact is mainly sought, or, in the case of refractories, resistance to heat. Here the thesis that "All the world is a ceramic product" finds nearly literal interpretation. Rock

materials in the condition in which we find them require little more than appropriate bonding to serviceable forms to be adequately resistant either to mechanical or chemical attack and the bonding is supplied by glassy matrices such as we have considered above. Temperatures may fall something short of those required to return the raw materials to the homogeneous liquid phase and merely represent a more convenient intermediate phase in the same process through which we sought to obtain glasses for industrial use.

This is perhaps the simplest statement of the glass and refractory problem as history has handed it down to us.

It was in the early sixties that Bunsen first developed the thought that glasses are merely solutions and are therefore subject to the same laws as other, more familiar solutions. A generation later in the eighties van't Hoff made a convincing application of this generalization in his study of the Stassfurt salts. It is perhaps less well known that at that time a definite plan had taken form in van't Hoff's mind to carry this study to higher temperatures and silicate solutions, but he was unable then to find either moral or financial support for his plan. Even the precise measurement of such high temperatures was then an unrealized dream. As late as 1905 he still expressed regret that he had been unable to carry out this plan because of its obvious usefulness to the silicate industry, which then, as indeed is often the case now, was dominated by secret formulas and tricks of personal experience which followed no law and formed a part of no system of generalization, but which nevertheless had been found useful by individual workers. It is within my own recollection that the chief thought and purpose of the American glass salesman was to convince his customers that the one glass made by his firm was better for all purposes than anything which his rivals in the trade could furnish. Today it is quite within the scope of a modern glassmaker to include in his trade list of available glasses several hundred different compositions each with a different specified purpose and application, and what is said here of glasses applies with equal generality to ceramic bodies and glazes, enamels, and vitreous coatings generally.

Here it is pertinent to remark that glass is by no means unknown in nature, although but little use has been made of it since the Indian first chipped his arrowhead from it. In the Yellowstone Park there is a mass of glass exposed to view which is about nine miles long and four miles wide, in which no more than occasional traces of more stable crystalline forms are found. This mass is known as Obsidian Cliff and is probably a lava flow, exposed to a thickness of 250 feet and perhaps extending to depths considerably below the present surface of the surrounding terrane. These volcanic glasses are fairly common in many regions of the earth's crust, although perhaps not often found in such large masses or in such accessible spots. Indeed the word "obsidian" applied to such glasses is common enough in geological literature (see Fig. 2).

It is altogether conceivable that such natural glasses when uncontaminated with crystalline phases or foreign materials might find direct application to the industrial arts through the simple process of quarrying them in their present form, but this has not been their history. The Yellowstone glass happens to be black because of a small percentage of iron in its composition and would not lend itself to those uses which require transparency as one of its attributes. It is, however, interesting to note here that Doctor Hale, in his search for a mirror disk of 200- or 300-inch diameter for the great astronomical telescope at Pasadena, seriously considered cutting out an appropriate section from Obsidian Cliff for this purpose. More careful consideration, however, indicated that for so exacting a requirement the natural obsidian might be found to have limitations which would prove a serious hindrance to its application to such a purpose. The glass is a surface flow and therefore occurs in layers in which presumably a different gas content and somewhat different rates of cooling may have prevailed. At any rate between the layers there are traces of incipient crystallization sufficient to indicate that physical properties such as the expansion coefficient, over a large surface of it, might not be uniform enough to insure homogeneous or symmetrical behavior under the exacting conditions required for an astronomical mirror. Considered also from the point of view of its merits as a glass, it is of rather high expansion for such a purpose and there might be difficulty in cutting a surface which would not be intersected by bubbles, sometimes of considerable size.

It is also possible to discover liquid glass in nature. There are still a few places scattered

FIG. 3.—Luminous molten lava in Kilauea, photographed at night.

over the crust of the earth where the solidification process for one reason or another has not carried through to completion and boiling lakes of liquid lava, which differ in no fundamental respect from glass melted in a tank, are found in a number of reasonably accessible localities. Of these the one most familiar to us is the lava lake of Kilauea on the Island of Hawaii (Fig. 3). The ramifications below ground of this great mass of molten silicates are not well known or easily inferred. The total quantity of it is therefore unknown but it is large. Single outpourings amounting in volume to a considerable fraction of a cubic mile are not unknown. There is another surface exposure of it at the summit of Mauna Loa on the same island which is in active eruption at the present moment, though because of its elevation (nearly 14,000 feet) it is difficult of access. The composition of these two vitreous masses is practically identical, indicating a common origin, though not necessarily a present physical connection. The composition of this glass differs widely from that of the Obsidian Cliff in Yellowstone Park. The latter is classified by geologists as a rhyolite characterized by 75% silica, 14% alumina, 1% lime, 8% alkali (soda and potash), and a number of other ingredients in smaller proportions. The Hawaiian glass is basaltic in composition with percentages of its chief ingredients about as follows: silica 49, alumina 17, lime 8, alkali 5, and iron oxides 19.

On the Island of Lipari in the Mediterranean occurs a natural glass of a composition such as to suggest the modern low-expansion glasses in its high silica content and comparative freedom from those ingredients which tend to raise this magnitude. Indeed this Lipari glass is in nearly universal industrial use at the present time exactly in the form in which it is mined, though perhaps this fact may not be so well known to students of the ceramic industry. Its content of silica is so high and its viscosity, while still molten, was so great in consequence of it, that it solidified at the surface in what we should de-

scribe as a silicate foam. It is better known to you under the name of pumice and these two mountains of pumice on the Island of Lipari supply nearly all the world with this useful scouring material.

We have already noted that the obsidian of Yellowstone Park is black or very dark red and not transparent except in very thin fragments. The volcanic glass on the Island of Hawaii on the other hand is quite transparent, somewhat cloudy perhaps, but in like thicknesses it often shows less color than a common beer bottle. The Liparite glass, as is well known to you, is pure white and if it were not for the fact that its viscosity and high gas content had determined its solidification in the form of a silicate foam it might very well have a high transparency, low expansion coefficient, and other desirable qualities.

Our present knowledge of the behavior of silicate solutions in the laboratory permits us to make for ourselves a reasonably clear picture of the cooling processes in such masses as these. The Yellowstone obsidian must have emerged at a fairly low temperature where its own viscosity and cooling rate were such as to prevent its crystallization. Its gas content compared with the other natural glasses mentioned must also have been relatively small, otherwise the stirring produced during the escape of the gas would doubtless have facilitated crystallization in local areas. The Hawaiian glass is of high gas content and low viscosity and its cooled product is crystalline, except in thin surface coverings where quick cooling permitted the vitreous condition to become fixed. The Liparite glass by contrast was not only highly viscous but possessed a high gas content as well. Its present fine, cellular structure indicates that this gas was uniformly in solution throughout the mass and therefore swelled the mixture to mountain form as soon as the pressure was removed. The quick cooling consequent upon the more or less rapid expansion here effectually prevented crystallization, although its high silica content may well have operated in the same sense.

There are other ceramic products, both natural and artificial, whose behavior lends itself to logical analysis in the light of our modern knowledge of the behavior of silicate solutions and the complete accord between the laws governing the behavior of these solutions at high temperatures and other solutions better known to us because of their greater accessibility. For example, one of the early problems of the Geophysical Laboratory was to endeavor to determine the precise ingredients and the manner of formation of Portland cement clinker. Hydraulic slow-setting cements had been known and utilized since early Roman times, though their earliest origin is not well known and the terms in which they are described have somewhat beclouded the details. It is a matter of simple chemical analysis to show that the chemical content of these early products differs in no essential respect from that of better known natural rocks. It is also true that artificial cements of this general character were in common use long before the Geophysical Laboratory came into the picture, but it was not known precisely what the combining ingredients were, or what the precise phase relation was which gave us such a robust crystalline product. Application of the theory of solutions to the three oxides, lime, silica, and alumina, did not prove to be a simple task because of the extremely high temperatures which it was necessary to reach in order that their phase relations in solution might be properly elucidated. Nevertheless these temperatures eventually proved to be accessible, measurable, and with the help of various ingenious devices born of experience, determined numerous phases in the formation process which were fixed by quenching and examined in detail under the microscope. Eventually the accumulated experience proved adequate to the task and a phase diagram for these three ingredients in all the useful percentage relations was set down so that the precise effect of even a very small change in composition would yield a predicted result. This diagram is now thoroughly familar to all of you and has found wide and continuous application through the Bureau of Standards and the special laboratories maintained by the cement industry. The earliest Roman "clinker" was probably of volcanic origin, perhaps laid down in widely distributed sheets of volcanic ash. Its chemical composition was determined by its source and the product, when treated with water, merely happened to be sound building material. Today, with our present knowledge, we may prescribe the appropriate ingredients to accomplish specific purposes just as with the glasses, and the results can be predicted with the same certainty, though the rate of reaction among the ingredients of the clinker is here so rapid as to be of a different

order of magnitude from that of the glasses. In consequence of this we approach equilibrium conditions at all stages of the development of a clinker while in the case of glasses we do not deal with complete equilibrium conditions but rather with suspended states where, notwithstanding this, considerable stability in the product is still possible.

John Masefield has somewhere said that an expert is always dull for he knows only his job and nothing of its philosophy. The time has been in the ceramic world when there seemed to be little philosophy, when secret formulas and private sources of supplies of raw material were the rule, without thought of advancement of the art or public demand. A man learned what his father knew and practiced his art at his own hearthstone. On the continent it used to be said that a glassmaker wrote his formula on the inside of his shirt because that was the only other thing which he never changed. Perhaps that was one of the reasons why American glassmakers were never much interested to imitate the European products. In our climate they preferred to wear no shirts. Be that as it may, the Europeans were perhaps the first to recognize and to set about the correction of this situation. The efforts of Schott and of Marquardt, of Bunsen and van't Hoff are well within the memory of all of us, which is perhaps but another way of saying that one of the very oldest industries in the world did not arrive at a philosophy of its own until our own generation. It is to the everlasting credit of Edward Orton, Jr., whose name we commemorate this evening, that the beginnings of this philosophy found a foothold on American soil, nor is there to be found in American science a more devoted group than the students and associates who have followed him in the effort to substitute a philosophy for a mere job.

I shall use two illustrations of the difference in spirit between these two points of view, the old and the new. The first was an accomplishment of the Geophysical Laboratory, which was at one time accounted the least in practical usefulness of all the activities founded by Mr. Carnegie. The second is an American glassmaking group, whose representative, Doctor Hostetter, has presided over the deliberations of the present Meeting as its President.

On many previous occasions I have told in public the story of the wife of the distinguished

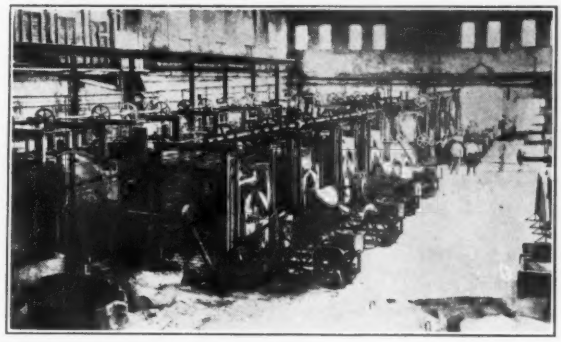


FIG 4.—Making optical glass on a large scale. Eight stirring machines in operation at Pittsburgh Plate Glass Co., Charleroi, Pa., 1918.

senator who could see no reason for trying to find out how rocks were formed so long as they could be purchased more cheaply than they could be made. Notwithstanding this reputation for the rather highly academic character of our studies, I have never failed to shout from the housetops the fact that of all the departments of activity of the Carnegie Institution of Washington the first to be called into war service in 1917 was the Geophysical Laboratory. Optical glass had never been made in quantity in this country. That it was indispensable to so many branches of the war service and could no longer be imported was one of the most disheartening conditions confronting us after our entry into the war. The story of the organized effort which was made and of its early and complete success is now a matter of record in our military archives and need not be referred to here. The point which I wish to bring out now and to commend to your serious consideration is what may be called the philosophy of the task. At that time (in 1917) optical glassmaking was still in the stage of the mysterious formula and the individual workman's skill. Such skill when transmitted from father to son through many generations became a superstition which might not be transgressed without peril and potential failure.

An instance of this in our experience may properly be mentioned here. When the Geophysical Laboratory was directed to make the attempt to produce optical glass it found practically all doors closed by this atmosphere of superstition. None but a trained optical glassmaker could make optical glass, so it was said, and these were to be found only in Europe. Earnest appeals to liaison officers to bring them

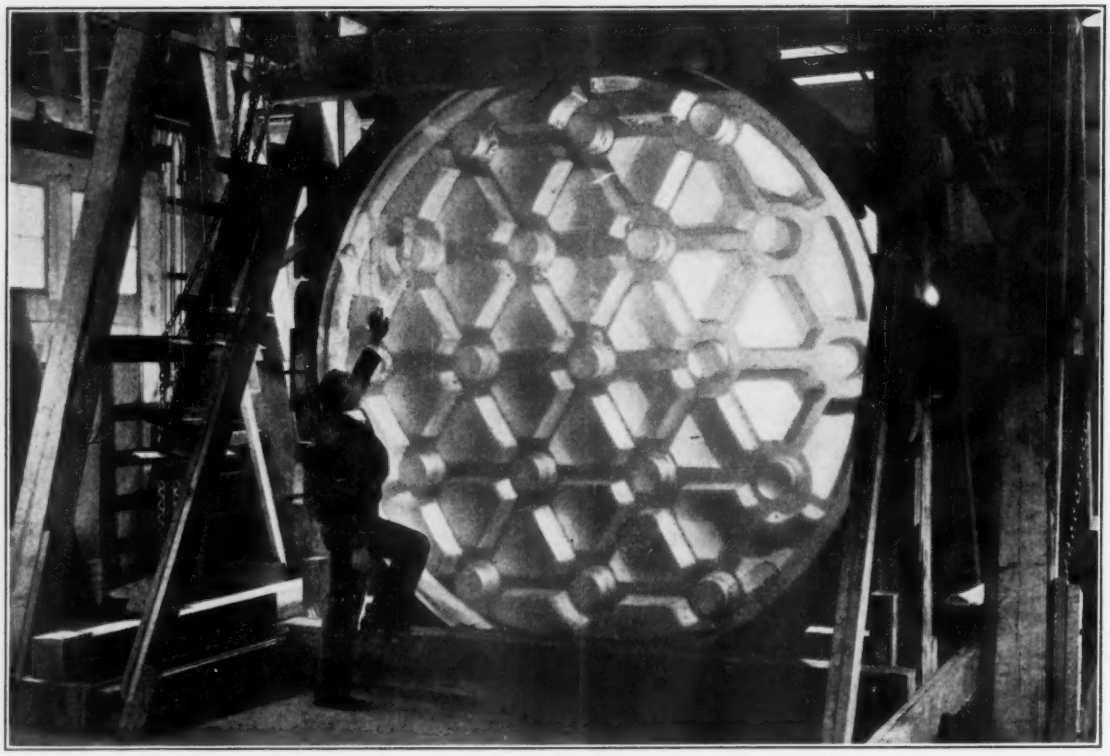


FIG. 5.—120-inch disk completed. Dr. G. V. McCauley inspecting the disk.

from abroad were entirely without result; they were all busy at home. No other course was open to us but to pursue the usual research methods and to discover what we could about this mysterious and altogether indispensable product. When called upon to make a crown glass of certain optical constants in the early days of the war we first analyzed an existing glass, one of the scanty remainders in the War Department's imported store. Not knowing what losses occurred during the melting and refining operations we made up three glasses, one exactly according to the formula provided by the analysis, the other two estimated to vary from this by 2 or 3% up and down from the specified government requirement. When these three glasses were made and their optical constants plotted, as might have been expected, no one of the three corresponded to the glass required, but the curve joining the three did contain the exact constants which we were required to provide. Thereafter it was a mere matter of routine to write the formula for the required glass by interpolation and to make it in the quantities needed.

This operation might perhaps be called the substitution of a philosophy for experience. To illustrate its practical value, however, I may perhaps say to you that a certain well-known European glassmaker once showed me a tray containing 200 samples representing 200 separate efforts to obtain a somewhat similar glass in the days when experience alone, without an underlying philosophy, provided the governing inspiration. We accomplished the same result in three trials, as I have indicated to you.

Another chapter in the same war history may be reported out of the experience of Dr. Morey of the Geophysical Laboratory. The pressure from the War Industries Board was very insistent. There was clamor for production and still more production. Nevertheless tradition had it that a pot of optical glass could not be developed in less than a minimum of 48 hours and frequently 60 to 72 hours; furthermore, stirring for homogeneity might never be undertaken until melting was complete. Morey's philosophy saw no reason why stirring in a glass melt should not operate as in any other solution and homogeneity would result the quicker if the stirring were practically continuous. Accordingly he pro-

ceeded upon this program and produced glasses of the highest quality in a 24-hour melting period (Fig. 4).

These accomplishments are incidents of the war story, but they are also of the highest importance in leading us out of the superstitious age of secret formulas and traditional procedure. Although but a few years have elapsed since the war and the events narrated above are but a foretaste of the splendid record of progress which has since been made in the glass industry, the death knell of the mysterious individual formula and the secret process has definitely been sounded. Any good student of the modern school can make almost any glass desired, unless entirely new properties are sought, in two or three trials and can forecast its properties with high precision. The physical chemistry of silicate solutions has provided the key to all of these relations with the utmost generality.

If I have confined myself hitherto to landmarks of venerable respectability my second illustration will describe to you the very latest, still incomplete, development of the glassmaker's art. It concerns the effort to make an astronomical mirror of 200-inch diameter for Doctor Hale and the California Institute of Technology. The "wise" man who is primarily solicitous for his own reputation reports only successful accomplishments and so is careful not to reveal details until the established result can be brought out to support them. Therefore I may say at once that the discussion of this particular problem at this time must remain incomplete because of the absence of the indispensable monument which should support it. The 200-inch disk has not yet been poured but the underlying philosophy of it has as much interest and value as though I were able to present its details on the screen.

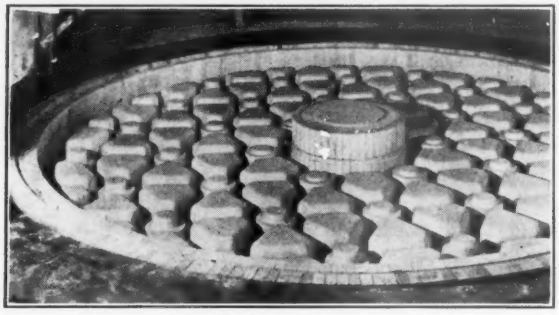


FIG. 6.—Ceramic mold for 200-inch disk in casting position; "beehive furnace" rolled back.

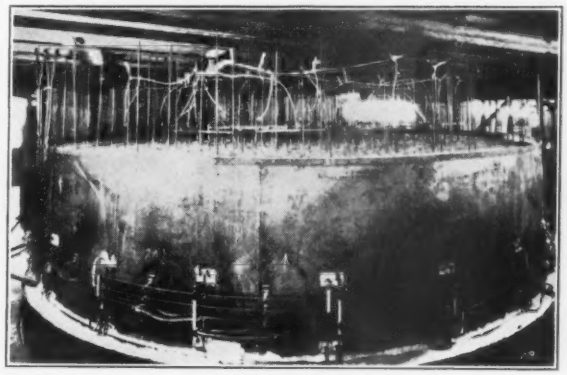


FIG. 7.—Exterior view of annealing furnace used for the 120-inch and 200-inch disks.

The great problem of the astronomer today is to be able to gather into his field of vision much more light than has hitherto been possible. The outer limits of space are now being explored as never before and the limitations which the exploration has encountered appear to be due mainly to insufficient light-gathering power in the great telescopes. Dr. Hale has himself written a little book to point out some of the possibilities of the extension of our knowledge if only the power of our instruments could be extended in the sense indicated. It will therefore not be necessary for me to lay before you in detail the astronomer's longings for greater range and power except by way of indicating the motive of the effort to provide a telescope which will increase the amount of light which we can bring into our field of vision, not by 10 or 20%, which in most lines of research is accounted an accomplishment, but four times as much as the largest existing telescope can provide. This largest telescope is the 100-inch reflector of the Mount Wilson Observatory and through its agency most of the great astronomical discussions of today have sought their fundamental data. Dr. Hale and his associates are among the great pioneers in this research program. The Rockefeller Foundation has endorsed it with its resources. President Houghton of Corning Glass Works and his Laboratory staff have had the courage to say that they believe a 17-foot mirror disk for this purpose is possible and have agreed to undertake the task of making it. To enter upon this pioneer adventure it has been necessary to assume that a glass of lower expansion coefficient than any heretofore used for

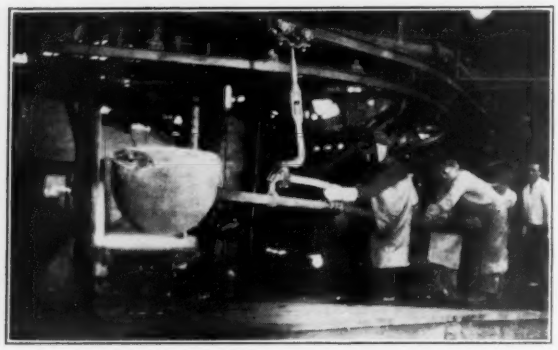


FIG. 8.—Transferring ladle of molten glass from melting furnace to mold.

large astronomical disks is possible, that it can be annealed so as to be as free from strain as a 30-inch disk, that it shall possess such chemical stability that it can be coated with a metal surface and recoated at will without losing its perfect figure, that its physical properties both thermal and optical, will be entirely symmetrical with respect to its center of figure, and that it can be so built that it can be supported in the telescope at a number of points sufficient to prevent it from sagging under its own weight in any position to which it may be turned. It is sufficient to say of this last requirement that its optical perfection must be measured in terms of the wave-length of light and that any approximation below this will result in imperfect images and failure. These requirements are the measure of the courage of the group of scientists which has undertaken this problem.

The particular significance of this requirement of maintaining the integrity of figure of the disk regardless of temperature changes or of the position in which the disk is held will best be seen from the radical character of the very first step in preparing for a 200-inch disk. This step was to substitute for the solid block or biscuit of approximately 40 tons weight a ribbed structure or grid of equal rigidity and approximately one-half the weight. Such a plan, so far as I know, is entirely novel and of course adds enormously to the technical difficulty of the problem. Nevertheless, if our philosophy declares it to be indispensable in our appraisal of the problem it will but waste time if we allow conventional experience, tradition, or superstition to interfere with it.

To the extent that experience is necessary to point out the influence of details upon this solution of the problem it was therefore determined to build such ribbed structures of several sizes leading up to the 200-inch disk. In pursuit of this plan a 30-inch disk was cast more than a year ago and its behavior compared with the solid disk of like composition and dimensions at the Astrophysical Observatory for differences of behavior while in use. Suffice it to say that up to the present none has been found. Following this a 60-inch disk of similar structure was cast and then a 120-inch disk. This latter has but recently come out of the annealing furnace and is of course still unfigured, but it appears to be entirely successful and at the moment enjoys the distinction of being the largest disk in existence to be cast in one piece. It is entirely symmetrical in structure, as may be seen from Fig. 5, and so far as a preliminary examination of it has provided a measure of its limitations it is as free from residual strain as the small 30-inch ribbed structure which has already been tested, and this in spite of the fact that its over-all thickness is 17 inches as compared with 4 inches for the first ribbed disk.

The mold for the 200-inch disk is ready (Fig. 6), the great annealing furnace, which, in appearance, suggests one of the great tanks in our oil-producing centers, is also prepared with complete heating equipment and electrical control such that no point of the disk during the cooling operation shall differ more than a degree or two from any other point, and the temperature gradient through the annealing zone shall be defined within a fraction of a degree each day (Fig 7). Pouring will be undertaken as soon as the glass is in just the right condition. Twenty tons will be required to fill the mold and about ten tons will be lost in the

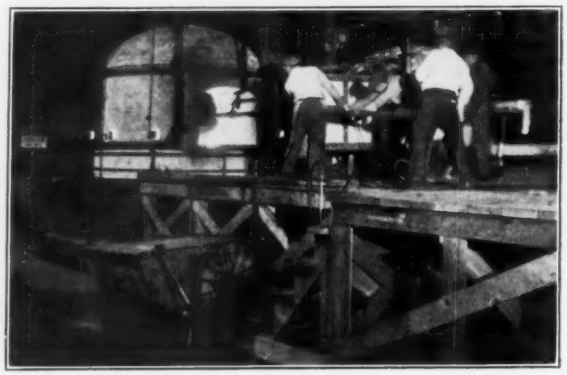


FIG. 9.—Pouring glass into a reflector disk mold maintained at high temperature by gas fire in the "beehive" furnace.

process. Fifty tons or more of homogeneous glass must therefore be ready in order to guarantee the integrity of the pouring operation, during which the complicated ceramic mold will be maintained at a high temperature. About ten months will be required for the cooling process in order to insure freedom from strain (Figs. 8 and 9).

The development of all of these indispensable requirements to possible success has been in the hands of Dr. George V. McCauley, a member of the research staff of Corning Glass Works and of the Glass Division of the American Ceramic Society, and it is a monumental tribute to the thoroughness of his study of the entire problem that among his associates of the Corning Laboratories, the astronomers, and others who have collaborated with him, there is today no doubt whatever of his ultimate success. Among all the preliminary efforts which have been made by way of leading up to the great 17-foot mirror there has been no failure. The glass used has a most extraordinary chemical stability and a linear expansion coefficient in arbitrary numbers of 26 as compared with 32 for the glass commonly sold under the Pyrex brand trade mark and 100 for the present 100-inch mirror which is in use on Mount Wilson. I entertain the utmost confidence that at the next Annual Meeting of the American Ceramic Society Doctor McCauley will himself announce to you the successful manufacture of a 200-inch disk for an astronomical mirror of a light-gathering power four times greater than any in the world today.

"There are more things in heaven and earth, Horatio,
Than are dreamt of in our philosophy."

EDITOR'S NOTE: The glass melt for the 200-inch disk was successfully poured on Sunday, March 25, 1934.

AN ANCIENT ART BECOMES A MODERN INDUSTRY*

BY ROBERT A. WEAVER

In this discussion the history of the art of enameling and its gradual development into a great industry is traced. The manner in which art and beauty have helped us prosper is pointed out and, further, it is shown how this prosperity may be unlimited if more and more consideration is given to the beauty of our products.

The new Union Terminal, at Cincinnati, Ohio, is an example of the possibilities of a real combination of art and utility. This building is magnificent in its beauty, color, and design. Every one entering or leaving the city must have a certain moment of exaltation at the sight of this beautiful structure.

Its noble designs and gorgeous colors would have been imperishable if used on some of the products produced by our industry. We have only to compare this great structure with examples of older station buildings, to realize what a tremendous change would come over the world and into our lives if such beautiful colors were substituted in all types of architecture in place of the uninteresting, drab, and ugly buildings we have been used to for so long.

A logical development of this subject would start with the history of the industry as an art. Now, as a matter of fact, the industry did start as an art, but its origin is so clouded in antiquity that it is almost impossible to be very definite regarding it.

The industry as a whole is being considered, and it will be assumed that the arts of making glass, brick, pottery, and enamel developed very much together.

It is unfortunate that we have no definite story of our early history. In Lamb's Essays is told the old story of the origin of the roasting of pork. A modest Chinese home burned and the family pig could not escape; the resulting appetizing odor indicated that a new culinary dish had been born. Glass, too, was accidentally discovered when a hot fire built in the sand produced a glassy substance.

Perhaps we can go one step further and find another Chinese home burning. In the charred remains some inquisitive Oriental finds his beautiful glassware has melted and deposited a fine

* Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Cincinnati, Ohio, February, 1934 (General Session, Ceramic Design Program). Received February 13, 1934.

glaze upon brick, a piece of pottery, or perhaps a metal vessel. This may be the way the art started.

In considering the history, we can assume that many of the industrial Divisions of the Society developed side by side. The history of one of the Divisions, that of porcelain enameling, will be emphasized in this paper.

The material which is called "enamel," or "porcelain enamel" or "vitreous enamel" to distinguish it from the organic finishes often called "enamels" (as bicycle enamel) was not mentioned in literature, as far as the writer has been able to discover, until about the ninth century. In the life of Leo the Fourth is found a reference to the word *smaltum*, a Latin word which comes down directly to our own use of the word "smelt." In this case it describes a hard vitreous compound which was fused upon the surface of metallic objects.

The word enamel comes from the French *émaille*, and is rather loosely defined as an "opaque glass, the shade of which can be varied at will."

The enamel, being a vitreous compound, can not be more antique than the discovery of glass. Josephus claims this discovery for the Israelites. There is much indisputable evidence, however, that enameling was being done many centuries before the birth of Christ.

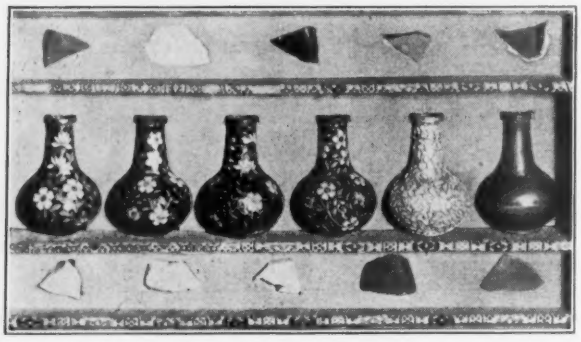


FIG. 1.—Six vases in various stages of completion showing process of cloisonné decoration.

The actual art of enameling is probably of Western Asian origin; gold ornaments and enameled jewelry, made in ancient Egypt and Assyria long before the birth of Christ, can be seen at the British Museum or at the Louvre. In a discussion with a Chinese antique dealer, the writer learned that at least 500 years ago there was a flourishing industry in China built on the imitation of antique enameled pieces. Imagine having a business of imitating antiques 500 years ago! You can understand the difficulty and confusion at this time in trying to trace original histories.

The Chinese early adopted the art and became masters of the intricacies of cloisonné. From China enameling undoubtedly travelled to Egypt and Greece, then on to Rome and from Rome to Great Britain.

The original work was done by artists, craftsmen of the highest order, and most of the objects were religious in character. The fine museums of Europe are filled with glorious examples. To the writer, the most interesting hall in the Louvre is the throne room of Louis the Fourteenth, now filled with beautiful pieces of antique enamels.

One of the finest pieces on display in this hall is the shield of Charles the Ninth. This is done on gold and the coloring is exquisite. It is about two feet high; the colors are red, sea blue, bright green, and flesh. A battle at sea is pictured, the colors as fine as any today. It must have been done by a master. In a nearby case is a lovely bowl which is thought to have been done by Cellini. In this same display are many items of various periods, dating from the fifth century on.

In the British Museum, one of the most distinguished examples is a Celtic shield which was found in the Thames, and which is still beautiful after 2000 years' subjection to the ravages of this brackish river.

The history of enameling is naturally intimately bound up with the various types of enameling with which we are familiar.

Roughly speaking, there are six types of enameling: cloisonné, champlevé, *basse-taille*, *plique a jour*, painters' enamel, and miniature, which might more properly be called industrial enamel.

Almost every one is familiar with cloisonné, which has become a mass production proposition with the Japanese and Chinese. In the hands of an artist, however, this type of enameling creates a most beautiful effect. The design is formed by soldering thin partitions, called cloisons, upon a metallic background or base. Afterward, the compartments thus formed are filled with enamels of various colors. In effect, the colors are separated by a delicate filigree of gold or copper. In the Metropolitan Museum there is a small case showing six vases in the various stages of being enameled in this manner. In the author's collection is a similar assortment (see

Fig. 1). The first example shows the metal base. Next is the base with cloisons attached. In the three succeeding examples different steps in applying the enamel are shown, and the last piece shows the vase after final polishing has produced the effect desired.

Any one studying the successive steps necessary in cloisonné enameling would certainly have a great appreciation of the difficulties encountered in producing some of the beautiful pieces displayed in our museums.

The next school of enameling, called the champlevé, produced a method which eliminated many of the difficulties encountered in cloisonné work. They simply took copper plates and hollowed out cavities for receiving the enamels, the raised parts remaining indicating the design. This simpler and more economical method flourished at the same time in the Rhenish region and at Limoges.

Limoges, at that time, began to take its place as the most important city in the history of enameling. Previous to this, work had been largely in the hands of the monks. Beginning about the 13th Century the monastic workshops were supplemented by civil workers, and from that time on the cathedrals of all Europe, from Seville to Stockholm, were decorated and enriched by enamels from Limoges. A mass production of art objects resulted, with the inevitable consequence of a loss of artistic values.

In Italy, during the 14th and 15th Centuries, the third type of enameling was developed, which is called the *basse-taille*, or translucent school. Here the artist first carved his subject in low relief. The carving, usually in silver, was then covered with translucent enamel which, after fusing, was level with the uncarved part.

The next development, though relatively unimportant as far as number of pieces produced, was the *plique a jour*, which was a combination of cloisonné and translucent. Although unimportant numerically, this school has produced some of the most beautiful of all enameled pieces. In the writer's collection is a spoon which is an excellent example of this work (Fig. 2). The divisions are made with small metal strips, but there is no metal base; only enamel divided by metal strips. When this is held to the light, an effect of cathedral glass is obtained.

The next development in enameling was really the beginning of enameling as it is known today. It was developed to a large extent in Limoges and flourished at the end of the 15th Century. At this point are found dated pieces with an authentic history. This school of "enamel painters" used, as a general rule, a coat of enamel and a firing to correspond with each color; the outlines were made with an etching needle, the artist scraping delicately the bright upper coat until the darker background appeared.

Soon after this, inspired perhaps by the French miniatures and by German engravings, they simply applied a dark ground coat which was covered with a white opaque enamel, and additional colors were applied by brush.

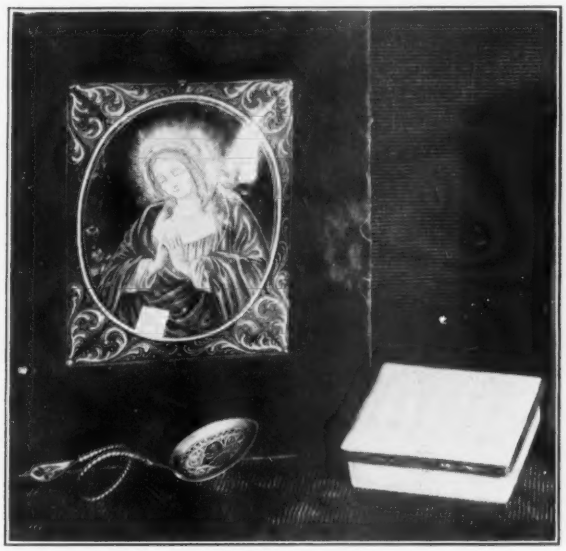


FIG. 2.—Spoon showing process of *plique a jour*. At the right: Snuff box with calendar applied by transfer method. (From the R. A. Weaver collection.)

One piece made by this school is signed and dated 1503. Some of our most beautiful examples of art enameling have come down to us from the "enamel painters." In many cases the colors are dazzling, especially the blues, and gold is generously used.

The glory of enameling as an artistic medium, and the glory of Limoges, reached the highest point during the life of Leonard Limosin, probably the greatest enameler of all times. None of the other Limoges artists attained his glory. He was born in 1505, came to Paris in 1545, where he worked for Francis the First with the title of Enameler to the King. His immense output includes all sorts of objects ornamented with mythological scenes after the Italian manner. The most valuable enamels in the world are his

FIG. 3.—Part of the R. A. Weaver collection of antique porcelain enamels.

twelve apostles, faithfully guarded in a little church in Chartres. His reputation was mainly assured, however, by his portraits. Of these there are 130, among them the sovereigns, Francis the First, Henry the Second, and Charles the Ninth. The decadence of the art of Limoges began about 1580 and was quite swift. In the 17th Century the family of Laudin did some notable work, and in the author's collection is a piece signed by one of the Laudins who was a Jesuit priest at Limoges (see Fig. 2). Incidentally, at a recent sale of art objects from the Ryan estate in New York, a number of the Limoges pieces were bought at fantastic prices running into thousands of dollars. In one of the galleries in New York there is a tray, perhaps eighteen by fourteen inches, decorated in fifteen or twenty colors. The depression price on this particular piece of Limoges enamel was $22,000.

The transition from art to commerce came rapidly, and the next school of enameling, called "miniature," was perhaps improperly named that. It was simply the enameling of small pieces by painting and was developed to its highest point about 1750 in Battersea, a suburb of London. They concentrated on snuff boxes, patch boxes, and novelties of various sorts. A snuff box owned by the author has a calendar apparently applied to it by the transfer method; the date is 1759 (Fig. 2).

One of the authorities stated that Battersea work started to depreciate in excellence when a printed design in place of hand work was adopted, and in a short time the industry practically ceased to exist. He went on to say that it was no great pity, for the noble art had by that time been completely degraded, in his opinion, and there remained only one more depth to which it could sink, and this it reached when the mode of applying enamel to iron was discovered and the walls of railway stations were covered with detestable enameled advertisements.

Perhaps this will indicate that the art reached its lowest point at that time and commercial interests began to dominate, for successively, thereafter, methods of applying this imperishable and beautiful material were found so that common household articles, such as enameled baths, kitchen utensils, and so forth, soon came on the market.

We find the art developing more and more into industry as it was discovered that the material had great utilitarian value, that refrigerators could be lined and stoves could be finished, eliminating household work and improving the durability of those articles. But it is in the field of architecture that friends predict its greatest future.

Gradually the possibilities of additional use of color in architecture has brought more and more attention to ceramic products. Here an opportunity is offered of combining beauty, color, and utility on a large scale. In London, some years ago, the author inspected a new building, whose exterior of black granite had a frieze of beautiful enameled decorations, extending around the entire top of the building. This was champlevé enamel on cast bronze, using very bright colors.

Our architectural journals have given considerable publicity to the porcelain enameled metal plaques recently executed for Radio City. These are huge mural ornaments of circular design, eighteen feet in diameter. Each of the plaques is placed sixty feet above the sidewalk, forming a complete decorative motif which artistically relieves the dead-wall expanse. They were made from sheet metal which was beaten and molded by hand before being covered with a richly beautifying and protective coat of enamel.

In the offices of the Ferro Enamel Corporation an experiment with the use of artistic enameled pieces as decorative material has been carried out. Mr. Winter, a promising young American artist, schooled in enameling in Vienna, has produced results which it is believed will lead to a great extension of this idea in architectural ornamentation.

Certainly there is a field for a similar artistic product for use in schools, restaurants, public buildings, theatre lobbies, and apartments. Stuart Chase, in his excellent book on Mexico, states that the homes of the well-to-do in our country are in violent contrast with those in Mexico. They are worse outside and better inside. In Mexico the eye follows the just proportions, the clean lines, and the blended colors and is at peace.

The great field of domestic housing today occupies a prominent place in all newspapers and magazines. It has been suggested that the government might aid in building thousands of homes. The curse of any general production method of building homes seems to be in the possibility of entirely too much uniformity in

appearance. This objection might be eliminated by using ceramic materials for exteriors and varying the color combinations in such a way that it would eliminate monotony.

Few people know the amount of research and development work being done in this field. At the Century of Progress, held last summer in Chicago, the exhibition of new types of houses proved to be one of the great attractions. A number of the homes were entirely finished in some product from the ceramic industry.

The Ferro Enamel Corporation sponsored the building of one home and has coöperated in the building of another, both of which were finished with enamel. It is reassuring to know that no serious mechanical or practical objection has been found with these homes, and that many people have been greatly interested in the beautiful effects that are achieved by the proper use of permanent colors. The house on display at the Century of Progress was visited by over one million people and will be on exhibition during the present year.

It is the author's opinion, after being quite close to this interesting development program, that the house of the future will be a combination, as far as the exterior is concerned, of brick, glazed tile, and enamel on metal.

The whole subject of a new change in our economic structure which may decentralize some of our industries and move them into smaller towns is most fascinating. If this change comes about, it should be the aim of all those in the American Ceramic Society to see to it that the fine qualities and products of this industry are kept constantly before the architects and the builders.

The ceramist has color to offer and today color is everything. He has permanency of color, low maintenance cost, and fireproof materials. All of these qualities appeal to the home builder and owner.

With the vision created by the possibilities for the ceramic industry in an enormous domestic building program, it is possible to forget enamel as an art material alone and to think of it instead as an artistic material that can be used in large quantities in many different industries.

It is obvious that the complete possibilities in the use of color can not be achieved until some inexpensive method of reproducing designs in colors and in quantities at reasonable prices has been perfected.

There has been a great interest in recent years in the so-called screen process which is an inexpensive method of applying vitreous colors through screens, rather than by spraying or brush application. Recent developments indicate that various industries in the enamel group will soon have this method in large-scale operation. It has been used on glass for years.

For the most part the groups in the ceramic industry are composed of craftsmen with artistic, rather than industrial, tendencies. Their perspective is spoiled by a close association with the materials in their shops, and because of this we lose sight of the possibilities of combining great art with modern industrial products.

Ceramists should look to the new profession of industrial designing which is described in such an interesting fashion in the February, 1934, issue of *Fortune*. It is said that when Dr. Sprague left Washington, he mentioned that the failure of industry to open up additional demands for industrial products was, in his judgment, the chief cause of the persistence of the depression.

Many of the older industries, such as textile, pottery, and furniture have always had the problem of "appearance." They have had designers on their regular payroll; the studio is a part of their plant.

In 1927 came the historic conversion of Henry Ford, who had previously dedicated his organization to the sale of transportation alone, but who at that time redesigned his car and acknowledged appearance as a sales factor. The depression has given the industrial designer his opportunity. *Fortune* states that pep meetings have petered out as producers of sales volume and the product has to be made to sell itself.

This article also mentions that famous designers have been called in to beautify washing machines, gas ranges, refrigerators, cooking utensils, kitchen sinks, and bathtubs. The ceramic industry may soon be another example of the revolution from old designs and old selling methods to new shapes, colors, and beauty.

In the so-called art industries, *Fortune* classifies pottery, tile, glassware, and enamel, but in the formerly artless industries they place refrigerators, scales, stoves, ranges, washing machines, and many industries that should rely on a branch of ceramics for their beauty. With new and attractive designs electric range sales of Westinghouse increased 600%; sales for Toledo Scales

FIG. 4.—Part of the R. A. Weaver collection of antique porcelain enamels.

increased 900%, and American Gas Machine's oil heater sales went up 400%.

The American Ceramic Society, therefore, has an opportunity to blend together the three elements of beauty, industry, and design. Ceramists can take the materials whose histories have here been reviewed, and the business methods, production, and speed for which our country is famous, and add to them the results of this new science and art of design. In this way we can create homes of such beauty and color that we shall keep our plants and workers busy producing those beautiful materials that in previous centuries could only be enjoyed by the very few.

FERRO ENAMEL CORPORATION
CLEVELAND, OHIO

ACTIVITIES OF THE SOCIETY

Officers of the Industrial Divisions

L. E. Barringer, Charles Harder	Art	R. C. Meeker, H. B. DuBois	Materials and Equipment	J. L. Carruthers, D. A. Moulton	Structural Clay Products
W. N. Harrison, B. J. Sweo	Ename	H. E. White, R. E. Birch	Refractories	R. F. Grady, Jr., H. E. Davis	Terra Cotta
James Bailey, F. C. Flint	Glass			Edward Schramm, T. A. Klinefelter	White Wares

FINAL ARRANGEMENTS FOR ASHEVILLE MEETING, APRIL 26 TO 28

There is only a short time left in which to plan to attend the Joint Meeting of the Electrochemical Society and the American Ceramic Society in Asheville, N. C., April 26, 27, and 28, 1934.

This is the Summer Meeting of the Society. In addition to an excellent program of papers on refractories prepared by leaders in the industry, there is the added advantage of meeting members of another technical group, the Electrochemical Society.

Headquarters for the meetings are in the Grove Park Inn where reservations may be made at the special rate of $7.00 per day per person, American plan. Reservations should be made directly with the Manager of the Grove Park Inn.

PROGRAM IN DETAIL

Thursday, April 26

9:00 A.M. Symposium on Dielectrics, Charles P. Smyth, Princeton University, *Chairman*. The papers will later be published in the *Transactions of the Electrochemical Society*.

12:00 NOON. Informal Luncheon in charge of the American Ceramic Society. Discussion of "Electric Firing of Ceramic Ware."

1:00 P.M. Plant trip to the Champion Fibre Co. at Canton, N. C., to which members of both Societies are cordially invited.

6:45 P.M. Dinner in charge of both Societies at which H. A. Morgan, President of the University of Tennessee, will address the members on the "Social and Industrial Aspects of the Tennessee Valley Project," and W. S. Lee, Vice-President of the Duke Power Co., will speak to the members on "Power Resources of the South-East."

Friday, April 27

9:00 A.M. Scientific-Technical Session on Refractories, sponsored by the American Ceramic Society. Both Societies will contribute manuscripts. The papers will later be published in the publications of the American Ceramic Society. (See Symposium on Refractories, p. 103.)

11:40 A.M. Members and guests of both Societies leave for trip to the Feldspar Mine, Kaolin Mine, and Feldspar Grinding Mills at Spruce Pine, N. C.

1:30 P.M. Buffet luncheon will be served at the Little Switzerland Inn on the crest of the Blue Ridge (elevation 3500 feet), where Harry A. Curtis will address the members on "The Chemical Engineering Program of the Tennessee Valley Authority." A charge of $2.00 will be made to cover transportation and luncheon for the trip from Asheville to Spruce Pine and return.

2:30 P.M. Leave Little Switzerland to visit the McKinney Mine and other feldspar operations at Crabtree.

3:30 P.M. Visit Sparks Kaolin Mine at Spruce Pine; Minpro Feldspar plant of Tennessee Mineral Products Corp.; Spruce Pine plant of Harris Clay Company.

Alternate Trip to Kyanite Mine and Plant of Celo Mines, Inc.

Leave Little Switzerland 2:30 P.M., or leave Spruce Pine 3:30 P.M. Visit mine and plant of Celo Mines, Inc. Joint party on return trip to Asheville at Burnsville 6:00 P.M. This party can also visit the feldspar plant of North State Feldspar Corp.

Trip for Ladies

Leave Asheville 11:40 A.M. for Penland weavers and potters. Southern mountain play; this play was given at the Century of Progress Exposition by the same people. Leave Penland 5:00 P.M., joining men at Spruce Pine for return to Asheville.

8:00 P.M. Informal Dinner.

ADDRESS: Progress in the Commercial Development of Kyanite in the South Atlantic States

BY V. L. MATTSON, Celo Mines, Inc., Burnsville, N. C.

ABSTRACT: This paper describes briefly the geologic occurrence of kyanite in the South Atlantic States from Virginia to Georgia. More detailed descriptions are given of those deposits that are being developed.

The general problem of kyanite concentration is reviewed, and a description of the Celo Mines concentrating plant is given. A small rotary kiln in use at this plant for calcining granular concentrate is described. Methods used in controlling grade of concentrate are referred to.

9:30 P.M. Organ Recital and Dance.

Saturday, April 28

9:00 A.M. Two parallel sessions—one of specific interest to members of the American Ceramic Society and the other of interest to the members of The Electrochemical Society.

12:00 NOON. Luncheon, Grove Park Inn.

1:30 P.M. Technical Session on Electroplating.
Golf Tournament and trip to the Smoky Mountain National Park.

5:00 P.M. Adjournment.

Some other plant and field trips are being planned by A. F. Greaves-Walker which will be of especial interest to ceramists. Electrochemists are welcome to attend.

The Kyanite Plant of Celo Mines, Inc.

A point of possible interest to members taking the Spruce Pine field trip is the mine and concentrating plant of Celo Mines.

A combination of induction-magnetic and electrostatic separators removes some twenty minerals that occur with the kyanite. Concentrates containing over 95% of kyanite are being made commercially. A small, continuous unit for producing mullite is also in operation at this plant.

Symposium on Refractories: Titles and Abstracts of Papers to Be Read by Members of the American Ceramic Society at Asheville Meeting

Chairman, HAROLD E. WHITE

1. Effect of Moisture on the Electrical Leakage through Typical Resistor Embedding Cements

By R. L. MELTON, KARL W. BROWNELL, AND G. J. EASTER, The Carborundum Company, Niagara Falls, N. Y.

ABSTRACT: The electrical impedance of cements for embedding heating resistors is found to be greatly decreased by exposure even to moderately moist air. This appears to be due to the presence in the cements of such ingredients as bentonite, mica, borax, or glass cullet, which are hygroscopic or break down electrically at relatively low temperatures. Curves are given illustrating these effects in both raw ingredients and commercial cements. The difficulty is shown to be largely overcome by proper vitrification.

The paper includes a discussion of alternating-current and direct-current testing methods and describes the method used to integrate various effects in which close control of the humidity by means of saturated salt solutions is a feature.

2. A Study of the Resistance of Fused Refractory Materials to Metallurgical Slags

By CHARLES MCMULLEN, A. A. TURNER, AND G. J. EASTER, The Carborundum Company, Niagara Falls, N. Y.

ABSTRACT: Solid slabs of fused material ranging in composition from 100% Al_2O_3 to 100 SiO_2 were tested in contact with cast iron and with brass at 1350°C, and the depth of penetration by metal or oxide was compared in the various cases. For iron melting 80% Al_2O_3–20% SiO_2 was found best and for brass 100% Al_2O_3. Ramming cements made from the fusions thus selected have shown superior results in service.

3. Casting of Thoria Crucibles

By H. K. RICHARDSON, Engineering Department, Westinghouse Lamp Company, Bloomfield, N. J.

ABSTRACT: Crucibles were made from thorium oxide by casting from a slip made according to ceramic practice. The presence of cryolite in the slip insured its successful use. These were fired to 1920°C in a gas furnace of special construction.

The addition of zirconium oxide makes easier crucible manufacture. The finished crucibles were successfully used in vacuum induction furnaces to melt pure metals to 2300°C. No contamination of the metals resulted.

Expansion curves indicate a peculiar action of the crucibles made with zirconium oxide in the 700 to 900°C region. The mean coefficient of expansion of fused thoria is 93×10^{-7} to 0 to 600°C.

The crucibles are (1) fairly resistant to chemical reagents, but not enough so for chemical work, and (2) resistant to wetting of molten metals of high melting point.

4. The Physical Properties of Insulating Refractories

By W. C. RUECKEL, Ohio State University, Engineering Experiment Station, Columbus, Ohio

ABSTRACT: An investigation of eleven types of insulating brick was made. Physical properties determined included bulk density, porosity, transverse and crushing strength, pyrometric cone equivalent, volume shrinkage at 2300°F, 2500°F, and 2700°F, sag under load at 2500°F, and resistance to spalling. A study of the relation between permeability and pressure differential through the various insulating brick is included in this report. Suggestions for classifying the various types of insulating brick into groups and a critical discussion of formulas for permeability are also given.

5. New and Improved Method of Electric Furnace Technique

By M. A. BAERNSTEIN, National Pigments and Chemical Co., St. Louis, Mo.

ABSTRACT: When a mixture of natural barium carbonate (witherite) with a 10 to 20% addition of a special fused barium oxide is added to an electric furnace: (1) the acid linings are protected, (2) spalls and disintegration are prevented, (3) absorption of Si, SiO_2, and other silicates by gray and high-test cast iron is prevented, (4) metals are washed and freed from inclusions already in them, (5) white cast iron (used to produce malleable mixtures) shows improvement in the properties of the metal and is rendered less susceptible to the absorption of mold gases and metal oxides, (6) low carbon steels are improved, (7) high sulfur-bearing ferrous alloys have their sulfur content materially reduced, (8) the atmosphere of the furnace is conditioned, the arc sustained, and the metal quieted, (9) slags in certain types of electric furnaces are made more fluid and less viscous, slag inclusions in finished castings and slag adherence to furnace walls are eliminated, (10) introduction of carbon to an alloy is aided, the solution of graphitic carbon and the efficiency of the reaction is increased. It also allows the operator to foretell the exact composition of his finished metal by eliminating conditions which promote variables, and serves to stabilize the phases of equilibrium.

6. Classification of Insulating Refractories

By E. J. BOGNAR, Corundite Refractories, Inc., Massillon, Ohio

ABSTRACT: Three classifications are given: I. Superrefractory insulators have, among other characteristics, a 40 to 50% alumina content, cones 32 to 34 fusion point (3092 to 3200°F), and a modulus of rupture of from 200 to 300 lb. They can be used up to operating temperatures to 2700°F. II. Refractory insulators are (*a*) those made of diatomaceous earth or kieselguhr base, having a fusion point between cones 23 and 30, a modulus of rupture of 150 to 300 lb., and to be used up to 2300°F; and (*b*) those with 25 to 28% alumina base, mostly of a synthetic mixture, having an optimum firing temperature of 2200 to 2300°F. III. Semi-refractory insulators include a large number of insulating brick on the market. They are classed as (*a*) diatomaceous earth brick or blocks which can be used up to operating temperatures of 1600°F and have a modulus of rupture from 250 to 300 lb., and (*b*) compounded brick with fusion points of at least 2200°F which can be used at operating temperatures up to 1600°F and have a modulus of rupture near 200 lb. A fair method of determining resistance to spalling and disintegration by H, N, NH_3, CO, CO_2, natural gas, producer's gas, etc., must be found. B. thinks the spalling resistance of refractories may almost be said to be inversely proportional to the alumina content.

7. The Current-Conducting Properties of Slag Baths at Electric Furnaces

By AXEL WEJNARTH, Eskilstuna, Sweden.

Paper to be published in *Transactions of the Electrochemical Society*.

PAPERS FOR THE ELECTROCHEMICAL SOCIETY

The following papers are among those accepted by The Electrochemical Society:

"The Voltage Balance of a Cell for Electrolysis of Sodium Chloride Solutions."—W. W. Stender, P. B. Zivotinsky, and M. M. Stroganoff.
"Electrodeposition of Aluminum from Non-Aqueous Solutions."—R. D. Blue and F. C. Mathers.
"The Corrosion of Zinc in Chloride Solutions."—C. W. Borgmann and Ulick R. Evans.
"The Potential of the Cobalt Electrode."—M. M. Haring and B. B. Westfall.
"The Hydrogen Overvoltages of Iron-Chromium Alloys in Potassium Hydrate Solution."—M. deKay Thompson and D. M. Fleming.
"Electrochemical Properties of Germanium."—J. Ivan Hall and Alfred E. Koenig.
"Liquid Insulators."—J. B. Whitehead.
"The Mechanism of Electrodeposition."—L. B. Hunt.
"Metallized-Glass Quinhydrone Electrodes."—E. Newbery.
"The Rate of Displacement of Copper from Solutions of Its Sulfate by Cadmium and Zinc."—C. V. King and M. M. Burger.
"Some General Properties of Liquid Organic Dielectrics."—Vladimir Karapetoff.
"The Relation between Oxygen Overvoltage and Catalysis."—A. D. Garrison and J. F. Lilly.
"Electro-Organic Oxidations in Concentrated Aqueous Organic Salt Solutions."—R. H. McKee and J. R. Heard, Jr.
"Electro-Organic Oxidations and Chemical Reactions in Concentrated Aqueous Organic Salt Solutions."—R. H. McKee and J. R. Heard, Jr.
"Two Types of Dielectric Polarization."—S. O. Morgan.
"The Development and Application of Synthetic Liquid Dielectrics."—F. M. Clark.
"The Development of Gaseous Conduction Lamps."—L. J. Buttolph.
"The Electrodeposition of Indium from Cyanide Solutions."—Daniel Gray.
"Anomalous Dispersion in Crystalline Solids."—J. W. Williams and C. E. Sun.
"Ductility and Adhesion of Nickel Deposits."—F. P. Romanoff.
"Glass as a Dielectric."—George W. Morey.

Other papers are now in the hands of the Publication Committee.

Train Fares to Asheville, N. C.

The Pennsylvania Railroad is giving very attractive rates for round trip tickets good for 18 days from the following cities to Asheville, N. C. For other cities, not listed, equally good rates are available.

To Asheville, N. C., and return

From			Lower Berth 1 way
Baltimore	$20.65		$5.00
Boston	43.70	(seat to N. Y.)	1.50
Buffalo	36.50		8.25
Chicago	28.30		7.25
Cleveland	27.30		8.25
New Haven	34.25	(seat to N. Y.)	.75
New York	28.10		6.50
Niagara Falls	37.40		8.25
Philadelphia	24.50		5.50
Pittsburgh	29.60		7.50
Washington	19.05		

The Southern Railway System is also giving the following rates to Asheville:

From	Rail Fare	Lower Berth
Boston, Mass.	$41.90*	$8.00†
Providence, R. I.	39.25*	8.00†
Springfield, Mass.	36.20*	7.63†
Hartford, Conn.	34.65*	7.48†
New Haven, Conn.	32.45*	7.25†
Albany, N. Y.	33.80	7.63†
New York, N. Y.	28.10	6.50
Newark, N. J.	27.75	6.50
Trenton, N. J.	25.80	5.63
Philadelphia, Pa.	24.50	5.50
Wilmington, Del.	23.40	5.25
Baltimore, Md.	20.65	5.00
Washington, D. C.	19.05	3.75
Pittsburgh, Pa.	29.50	6.00

* Passengers from these points should purchase round trip 30-day tickets to New York, then purchase round trip 18-day Winter Tourist tickets from New York to Asheville (combination of which is quoted above).

† Pullman rate from these points is based on Parlor Car seat to New York, plus lower berth from New York to Asheville.

SPRUCE PINE MINING CENTER TO BE VISITED

By B. C. Burgess*

A most interesting trip is planned for those attending the first joint meeting of the American Ceramic Society and the Electrochemical Society at Asheville, N. C., April 26 to 28. This is the trip on Friday, April 27, to the picturesque little mountain town of Spruce Pine, center of the mining, farming, and tourist section known as "Mayland," from its delightful setting and the initial letters of the three counties, Mitchell, Avery, and Yancey.

This prosperous, energetic little mining town reminds one more of the western mining camps than it does of the usual southern country village. It is located near the head of the Toe River valley where the Clinchfield Railroad leaves the river and plunges through a great tunnel near the summit of the Blue Ridge to start its precipitous descent down the Atlantic drainage.

Spruce Pine, in addition to being located on the railroad and Toe River, a tributary of the Tennessee River, is also at a ford of the river which has been an important crossing since pre-Revolutionary days and now forms the focal point of five important highways.

However, Spruce Pine is not an old village but a very young one, spring-

B. C. Burgess

* Chairman of Local Committee for joint meeting. Received March 26, 1934. Mr. Burgess is manager of the Tennessee Mineral Products Corp. (controlled and operated by United Feldspar Corp., sole sales agents, E. I. du Pont de Nemours & Co., Inc.)

ing from the railroad construction camp established there only thirty years ago and taking its character from the tunnel-driving activities of its ancestors.

It is in too beautiful a section of the country, however, to confine its activity to mining. Lumbering operations probably preceded somewhat the mining and farming follows and accompanies both. The good transportation facilities have brought in tourists, and all of these activities have combined to form a center most interestingly diversified as to vocations and attractions, with ideal climate for both.

Mica was the first mineral to be obtained commercially in this section. Its mining began shortly after the Civil War. The high value of the clear sheets (isinglass) enabled it to be profitably mined in spite of the lack of anything except oxcart transportation in those days. As soon as the railroad was completed into Spruce Pine work was started on the great deposits of feldspar, kaolin, and flint, some of these having been cut by the railroad excavation. In the ten years following the first shipment of feldspar in 1911, North Carolina became the principal feldspar-producing state in the Union. It has maintained this position since, now producing about 60% of all the feldspar in the United States and practically all of this is mined in Mayland.

During the last few years an intensive search has been made for kyanite and enormous disseminated deposits have been found, one of which is being successfully operated by a local concern.

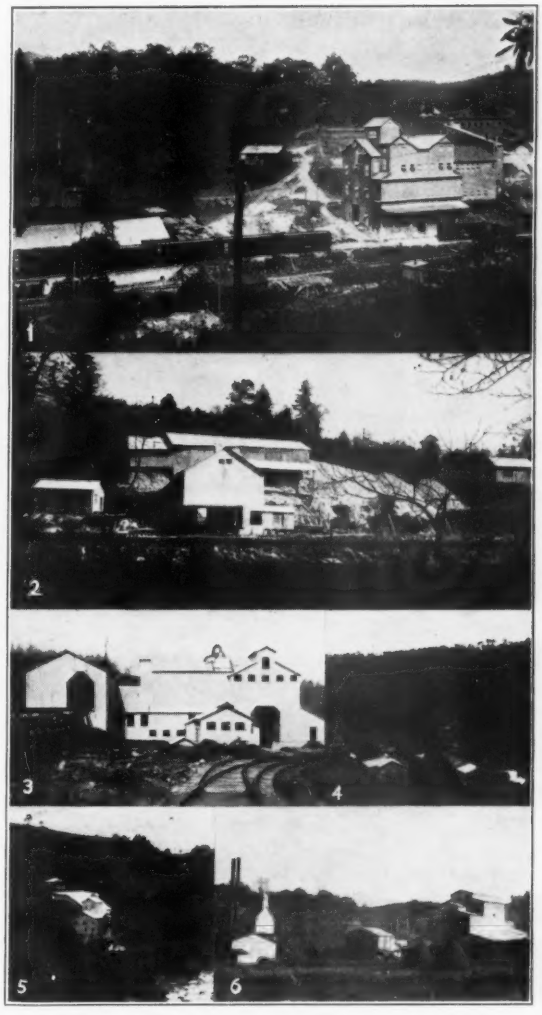
Another mineral which is recently coming to the fore in this section is olivene. Due to the economic situation resulting from depreciation of our currency, importers of magnesite have turned their attention to this other magnesium silicate, large deposits of which have long been known to occur in western North Carolina. Recent work by the Bureau of Standards shows the North Carolina olivene to have special refractory properties. One olivene deposit has been opened in the Mayland area and another further west in the State.

Other interesting and important minerals found in this section are iron, chrome, nickel, beryl, manganese, columbite, and uranium. The iron and its alloys suggest the opportunity for development of those increasingly important special steels.

Spruce Pine is within the area of the Tennessee Valley and therefore a part of that great area under development by the Tennessee Valley Authority. Due to its special resources and location the Authority has selected the Spruce Pine area in which to carry out experiments believed to be of great economic and sociological importance, not only to the Valley but to the whole United States.

The enormous quantity of power the Authority will have available is of special importance to ceramists and electrochemists because it provides electricity at rates which make electric firing economical.

Come to the joint meeting in Asheville and take the trip to Spruce Pine. See the care and expense incurred by the large, well-manned organizations which are producing your ceramic raw materials. See the reserves of these and the new ceramic materials which insure permanency and uniformity of output for many years to come. See the opportunities which the natural resources combined with enormous quantities of cheap electric power will provide.



(1) Minpro plant, Tennessee Mineral Products Co., Spruce Pine, N. C., (2) Consolidated Feldspar Corp., Spruce Pine, N. C., (3) Feldspar Milling Co., Bowditch, N. C., (4) Sparks plant of Harris Clay Co., Spruce Pine, N. C., (5) Southern Feldspar, Toecane, N. C., (6) North State Feldspar Corp, Micaville, N. C.

Relax in the invigorating April climate of Mayland. Ask any one who has been there. The trip will do you good. You can not afford to miss it.

ERRATA

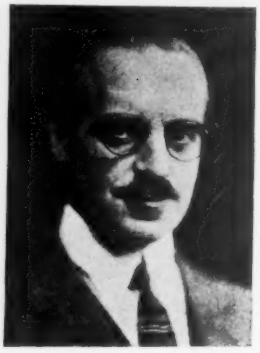
The Editor of *The Bulletin* wishes to call attention to errors in the legend titles for cuts on pages 47 and 48 in the February *Bulletin*.

The right-hand cut, page 47, should read, "Kyanite plant of Celo Mines, Inc., near Burnsville, N. C." The left-hand cut, page 48, should read "McKinney Mine of Consolidated Feldspar Corporation, near Spruce Pine, N. C."

NEWLY ELECTED DIVISION REPRESENTATIVES OF BOARD OF TRUSTEES

The Art, Enamel, and Refractories Divisions this year elected their representatives to the Board of Trustees for the next three-year period.

Frederick H. Rhead Frederick Hurten Rhead of the Homer Laughlin China Company, Newell, W. Va., was elected to the office of Trustee by the Art Division members. Mr. Rhead is a long-time worker in the Art Division and has held various offices in that Division in the past twelve years. In more recent years, however, since his affiliation with the Homer Laughlin China Company, he has also been active in the White Wares Division. A biographical sketch of Mr. Rhead was published in the January issue of the *Journal* for 1923. From 1920 to 1925, Mr. Rhead served as chairman of the Art Division, chairman of the White Wares Division, and vice-president of the Society; and trustee in 1926 and 1927.



F. H RHEAD

Walter C. Lindemann Mr. Lindemann as Enamel Division Trustee was reëlected to this office. In 1932 he was elected to the same office to fill the unexpired term of Mr. Poste who took the office of president of the Society. Mr. Lindemann is factory manager of the A. J. Lindemann & Hoverson Company, Milwaukee, Wis.

W. C. LINDEMANN

Robert B. Sosman

Dr. Sosman was elected to the office of Trustee of the Refractories Division. He is also serving as vice-chairman and is a member of the Editorial Committee of the Refractories Division. A brief biographical sketch follows: Born, Chillicothe, Ohio, 1881; B.Sc., Ohio State University, 1903; S.B., Mass. Inst. Tech., 1904, Ph.D., 1907. Laboratory, Arthur D. Little, Boston, 1906–1908; physicist, Geophysical Laboratory, Carnegie Institution of Washington, 1908–1928; assistant director and physical chemist, United States Steel Corporation, 1928– . Consulting chemist, Ordnance Dept., U. S. A., 1918; lecturer on geophysics, Mass. Inst. Tech., 1925–1926. Member of the A.A.A.S., Amer. Chem. Soc., American Ceramic Society, Amer. Physical Soc., A.I.M.M.E., Amer. Iron and Steel Inst., Geol. Soc. of America, Washington Acad. Sciences (president, 1928), New York Mineral Club, English Ceramic Soc., and Deutsche Keramische Gesellschaft, Sigma Xi. Author, The Properties of Silica, 1927, and papers in scientific periodicals on high-temperature thermometry, refractories and mineral chemistry, and physics.

ROBERT B. SOSMAN

At the 1933 Meeting of the American Ceramic Society, he was chairman of the "Symposium on the Physical Chemistry of the Alumina-Silica Refractories" and at the 1934 Meeting was chairman of the "Symposium on Crystalline Substances in Refractories," taking the place of the late Edward W. Washburn.

HONORARY MEMBERS OF THE AMERICAN CERAMIC SOCIETY

DR. ARTHUR LOUIS DAY, Director, Geophysical Laboratory, Washington, D. C.	January, 1932
PROFESSOR H. LE CHATELIER, Paris, France	1934
DR. J. W. MELLOR, Director, School of Science and Honorable Secretary, The Ceramic Society, Stoke-on-Trent, England	1931
DR. OTTO SCHOTT, Jenaer Glass Works, Jena, Germany	January, 1932
DR. W. E. S. TURNER, Secretary, Society of Glass Technology, The University, Darnall Road, Sheffield, England	1934

1934-1935 OFFICERS FOR THE NATIONAL BRICK MANUFACTURERS RESEARCH FOUNDATION

President: Henry C. Kleymeyer, Standard Brick & Tile Co., Evansville, Ind.
Vice-President: C. Forrest Tefft, The Claycraft Co., Columbus, Ohio.
Secy.-Treasurer: D. F. Stevens, Acme Brick Co., Danville, Ill.

The newly elected trustees, whose terms will expire in 1937 are as follows: H. C. Kleymeyer, Evansville, Ind., C. W. Parmelee, Urbana, Ill., and Amos P. Potts, Brazil, Ind. Those whose terms expire in 1936 are E. E. Krauss, Philadelphia, Pa., John D. Martin, New Straitsville, Ohio, and Eben Rodgers, Alton, Ill.; those whose terms expire in 1935 are C. Forrest Tefft, Columbus, Ohio, J. Oatis Wilcox, Alliance, Ohio, and D. F. Stevens, Danville, Ill.

The Committee on Research Committees consists of C. W. Parmelee, *Chairman;* D. F. Stevens, H. C. Kleymeyer, E. E. Krauss, and J. O. Wilcox.

MINUTES OF COMBINED MEETING OF COMMITTEE ON PUBLICATIONS AND DIVISION EDITORIAL COMMITTEES

The meeting was held on February 12, 1934, at the Hotel Netherland Plaza, Cincinnati, Ohio.

The following members were present:

(1) *Publications Committee:* M. F. Beecher, R. M. King, L. J. Trostel, Louis Navias, and Ross C. Purdy.
(2) *Editorial Committee Members and representatives of Divisions:* R. D. Cooke, S. J. McDowell, H. E. White, R. A. Heindl, E. W. Tillotson, G. V. McCauley, B. T. Sweely, J. L. Carruthers, and R. E. Birch.
(3) *Editor's office:* Emily C. Van Schoick and Mary J. Radcliffe.

I. Refractories Division Procedure

Mr. Heindl explained the procedure of the Refractories Division Editorial Committee as follows: When any paper on refractories has been submitted by any author for publication in the *Journal of the American Ceramic Society*, it is sent by the Editor to Mr. Heindl as Chairman of the Refractories Division Editorial Committee. After reviewing it, the Chairman passes it to the second member of the Committee who then passes it to the third. After this review by each member of the Committee, it is returned to the Chairman (Mr. Heindl) who reports for the Committee and sends the paper to the Editorial office with the Committee's recommendations. It was pointed out that this method of returning the paper to the Editorial Committee Chairman for preparation of the report has a number of advantages, including the impersonal nature of the criticisms which then come from the Committee and not from each of the three individuals.

II. White Wares Division Procedure

S. J. McDowell, reporting for the White Wares Division, said that the procedure of that Division's Editorial Committee differed from the procedure followed by Mr. Heindl's Committee in that the papers were not returned to the Chairman of the Editorial Committee after other members of the Committee had reviewed them. It was agreed that the plan followed by the Refractories Division was advantageous.

III. Glass Division Procedure

Dr. Tillotson and Dr. McCauley, reporting for the Glass Division Editorial Committee, stated a preference for sending copies of the papers simultaneously to each of the committee members. This, of course, is seldom possible since the contributor does not often provide three copies of his paper. Dr. McCauley stated that his Committee had often called upon experts, not members of his Committee, to read various papers.

IV. Structural Clay Products and Enamel Division Procedure

Professor Carruthers, in reporting for the Structural Clay Products Division Editorial Committee, stated that his Committee has followed the practice of the White Wares Division, that is, of not returning the papers for a second review by the Committee Chairman. This practice has also been followed by the Enamel Division Editorial Committee whose report was given by R. D. Cooke.

It was agreed by all present that the Editorial Committees are at liberty to submit papers for review to others who are not members of their Committees. In fact, this practice is recommended where the Committee member does not consider himself fully competent to criticize the technical details of any paper.

V. Recommendations

The following items received the consideration of the combined Publications and Editorial Committees and the recommendations listed were made.

(1) Editing Journal Papers

(*a*) It was brought out that the Editorial Office should edit all papers before sending them to the proper Division Editorial Committee. (See Proposed Constitution and By-Law Amendments, Article XI, *The Bulletin*, Volume 16, p. 102, April, 1933, 5th paragraph.)

(*b*) It was agreed that if the Editor performed this function much of the Editorial Committees' time would be saved and that, since the Editorial Office must carefully edit the papers eventually, it would not mean a complete duplication of this phase of the Editor's work. It was recommended that the Editor carry out this function to the greatest possible extent. The situation in the Editor's office was fully discussed and understood.

(*c*) The Committees consider it essential that all papers published in the *Journal* should have technical editing. Papers whose major interest does not fall under the supervision of any one of the Division Editorial Committees shall be referred to the Chairman of the Publications Committee who may refer the papers to persons whom he may choose for technical review.

(*d*) If for any reason any Division Editorial Committee is inactive and can not be obtained to review a paper which would normally fall under its supervision, the paper shall be referred by the Editor to the Chairman of the Publications Committee who may refer it to persons whom he may choose for technical review.

(*e*) It is recommended that "Suggestions to Authors" be made available through reprinting.[1] It was agreed that a rewriting of these suggestions to shorten them would be advisable. The Publications Committee will coöperate with the Editor in these revisions.

(*f*) It is recommended that the course of papers received for publication shall normally be (i) Editor, (ii) Chairman, Division Editorial Committee, (iii) second member committee, (iv) third member committee, (v) Chairman, Division Editorial Committee for second revision and for preparation of Committee's report, (vi) Editor.

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[1] See *The Bulletin*, **12** [1], 28–29 (1933).

(2) Papers Not Suitable for Journal or Bulletin The Committees consider it good practice for the Editor to return to the author papers which are not suitable for publication in the *Journal* or *The Bulletin*. These need not be submitted to any of the Division Editorial Committees for the settlement of this point unless the Editor so wishes.

(3) Bulletin Papers In sending a paper to the Editorial Committee, it is recommended that the Editor shall mark that the paper is suitable for (*a*) *The Bulletin*, or (*b*) the *Journal*. Anything which is definitely a *Bulletin* paper need not be referred to the Editorial Committee. A minority, however, felt that technical papers for *The Bulletin* should also be sent to the Editorial Committees.

(4) Abstracts (*a*) Articles which have been published and abstracted should not be abstracted again when published in another publication. The Editor should select the abstracts of articles at their source.

(*b*) It is suggested that in the case of noteworthy articles presenting original results of equilibrium melting diagrams of interest to ceramic people that the diagrams should accompany the abstract. The attention of the Editorial Offices is called to the practice of the *Journal of the Society of Glass Technology* in this connection.

LOUIS NAVIAS, *Chairman*
R. E. BIRCH, *Acting Secretary*

REFRACTORIES DIVISION ANNUAL MEETING MINUTES*

The annual business session of the Refractories Division was held on February 14, 1934. Reports of committees were presented.

The following nominees for Division officers were proposed by the Nominating Committee and were elected: *Chairman*, H. E. White; *Vice-Chairman*, R. B. Sosman; *Secretary*, R. E. Birch; *Nominating Committee*, S. M. Phelps and R. A. Heindl.

It was announced that R. B. Sosman had been elected by ballot as Trustee to represent the Division.

The results of an informal mail ballot on the adoption of A.S.T.M. Standards as standards of the Society were presented. Fifty-six ballots were received.

The following Standards were approved by large majorities: Definitions C71–31 and C27–28; amended specifications C63–28, C64–24, and C65–28; Methods C67–31, C16–20, C18–21, C92–32T. Method C24–33 (P.C.E. test) was approved as amended, but 19 of those voting were opposed to the requirement that all cones above No. 20 should be used simultaneously; 17 were opposed to Method C38–33T (spalling test). On the question, "Is the publication of the A.S.T.M. Standards in the American Ceramic Society's Book of Standards advisable?" the vote was No, 29; Yes, 26. On the question of screen-scale designations, 10 voted for the Tyler Standard alone, 20 for the combination of Tyler and U. S. Standards, and 13 were opposed to both forms.

After discussion of various items of the ballot, the following motion was passed: The Refractories Division recommends that the forthcoming Book of Standards of the American Ceramic Society carry in its section on Refractories only a reference to the A.S.T.M. Standards and Tentative Standards on refractories.

NOTE: The Annual Report of the Refractories Division Research Committee will be published in a subsequent issue of *The Bulletin*.

* ROBERT B. SOSMAN, *Secretary*.

PROGRESS REPORT OF THE COMMITTEE ON DATA*

Mr. Booze suggested early in the year that the Committee arrange to gather reliable data (entailing experimental work by the Bureau of Standards) on thermal expansion and heat conductivity of various types of refractories.

Following an animated discussion by mail with R. C. Purdy, Ellis Lovejoy, J. M. McKinley, F. A. Harvey, S. M. Phelps, and G. J. Bair, it was decided that Mr. Phelps should be instrumental in having the Mellon Institute gather and publish existing data on the above properties prior to determining what is to be done in the way of experimental work (for the Committee on Research).

Mr. Lovejoy, at the request of the general chairman, arranged all necessary data on scumming and efflorescence for handy reference. These data were published in the January issue of *The Bulletin*, page 22, under the title of "Classification of Florescence." Reprints were also available at Cincinnati. The chairman considers this contribution very valuable.

The chairman has given much study to the idea of collecting data and has made a number of data abstracts from the *Journal* as a trial, but he realizes the magnitude of such an undertaking. There remains a considerable amount of fundamental and important data from the ceramic literature published throughout the world.

It has occurred to the chairman that (as far as our *Journal* is concerned) such a compilation could be much better accomplished with the help of the respective authors themselves. The Secretary of the American Ceramic Society could suggest that each author submit with his paper a brief statement of the data involved and obtained. Authors of published papers should be asked to submit such data where possible. Whether thus the beginning of a real data collection could be realized remains to be seen; it would be worth a trial in view of the fact that no additional cost to the Society would be involved.

This matter will be taken up more fully during the coming year, but expressions from the president, secretary, and committee members would be welcome now and later. Additional questions suggested by the above comments and also by other committee members will be taken up during the coming year.

T. W. GARVE, *General Chairman*,
Committee on Data

* For the first year, 1933.

LARGE-SCALE PHASE EQUILIBRIUM DIAGRAMS

At the meeting of the Refractories Division in Cincinnati we announced a project for reproducing in colors the four ternary composition-temperature diagrams of the four refractory oxides: silica, alumina, lime, and magnesia, on a scale large enough and accurate enough to permit of interpolation to 0.1%, which is possible on a 500-millimeter triangle. Since such a reproduction is as exacting as a high-grade topographic map it is too expensive to be justifiable in the budget of an industrial laboratory, but we assumed that there would be a sufficient number of other laboratories interested in having such diagrams to make possible a fair distribution of the cost. The response at Cincinnati encourages us to proceed with the project on the basis of a charge not to exceed two dollars per set of four diagrams.

The work has been entrusted to a skilled map-maker, the Williams and Heintz Company of Washington, D. C. The base is a 500-millimeter equilateral triangle divided to 5 mm. (1% in composition), engraved for this purpose and accurate in the original to 0.1 mm. We have recalculated the compositions and have replotted many of the original data of the Geophysical Laboratory, making minor revisions in the original diagrams to take account of later work, and have prepared the drawings by the same methods as are used for colored topographic maps. The base will be in blue, temperature contours in green, compositions (including solid solutions) in red, and boundary curves and primary phases in black. The sheets will be 19 by 24 inches, of map paper. It is expected that the work will be finished about the middle of May.

RESEARCH LABORATORY
UNITED STATES STEEL CORPORATION
KEARNY, NEW JERSEY

ROBERT B. SOSMAN
OLAF ANDERSEN

ANNUAL REPORT OF THE COMMITTEE ON SECTIONS AND DIVISIONS

Local Sections

During the past year there have been Local Sections of the Society under the following designations: Baltimore-Washington, California, Chicago, Pacific-Northwest, Pittsburgh, and St. Louis. The Committee has contacted each of these Sections asking for reports as to organization and operation, and has offered to be of any possible assistance to them. All but one of the Sections have responded and the data have been tabulated and appended.

EDITOR'S NOTE: A report of the reorganization of the Michigan-Northwestern Ohio Section and of the California Section was published in the March *Bulletin*, page 79.

A brief summary with reference to each Section is as follows:

Baltimore-Washington This Section has a paid-up membership of forty and a mailing list of one hundred and ten persons. Three meetings per year are held alternating between Washington and Baltimore, with an attendance averaging from thirty-five to forty. Most of the speakers are from the Bureau of Standards and they feature informal discussions in connection with the papers presented. A dinner precedes the meetings and, in general, they stress the social phase of their work.

California This Section was apparently inactive for a year, but in October, 1933, they held an enthusiastic reorganization meeting. A year's program of five meetings has been planned (see Editor's Note).

Chicago This Section has a normal membership of about twenty-five, but it has dropped off recently. The meetings are held quarterly and once a year jointly with the Chicago District Enamelers Club. A Committee from this Section was active in making local arrangements for the Summer Meeting of the Society. The American Ceramic Society members in Chicago are chiefly enamelers and the activities of the Chicago District Enamelers Club have quite naturally impaired the success of the Local Section. It is possible that an effort should be made to include in this Section members within wider geographical limits. The Section apparently is not in danger of becoming inactive, but it is not particularly flourishing.

Michigan-Northwestern Ohio After several years of inactivity this Section has held a reorganization meeting. A plan of activity was approved and apparently a good organization is to be developed (see Editor's Note).

Pacific-Northwest This Section is well organized, but definite information is lacking as to its activities. There was an attendance of thirty-eight at its annual meeting.

Pittsburgh This group has a membership of one hundred seventy. Meetings are held monthly with programs planned well in advance. Speakers are readily available from Mellon Institute and the Bureau of Mines, which seems to assure the Section of good programs.

St. Louis The Committee has had no direct report from this Section but from information appearing in *The Bulletin* there are indications that it is reasonably active. It has featured plant visits in connection with the meetings.

Northern Ohio In addition to the above Sections there is one organization which seems to have been inoperative for some time. This is known as the Northern Ohio Section and was one of the early units to be organized. This Committee has communicated with several men in Cleveland to ascertain a reason for the present condition and to find out the prospects for a revival of interest. It has been suggested that interests in Cleveland and vicinity are so diverse as to make a local section difficult to administer without a great deal of time and attention by a few enthusiastic individuals, and several persons of that type, formerly active, have moved away. It is possible to enlist members living in and within thirty miles of Cleveland if some one can be found who is willing to put in considerable time and effort on the project.

Early in 1933 local efforts were made toward the organization of a Section in San Francisco, but recent information indicates that there is no activity along that line at present.

Summary The Committee is led to believe that but two of the Local Sections have been very active the past year, namely, Pittsburgh and Baltimore-Washington. In both of these cases the presence of scientific institutions contributes interest through members and available speakers. The California and Michigan-Northwestern Ohio Sections are reorganizing and give promise of healthy activity.

The Chicago Section seems to present a particular problem due to centralization of interest, while the Northern Ohio may have suffered inactivity due, in part, to diversification of interest.

Student Branches

New York State College of Ceramics There is every indication of a healthy condition with this Branch. They have annual dues of $1.00 per year, hold monthly meetings, and endeavor to get speakers from plants engaged in various branches of ceramics. They were well represented at the Annual Meeting, twelve students attending.

Georgia School of Technology Following a period of apparent inactivity, an effort is being made toward the reorganization of this Branch.

Iowa State College This Branch has fifteen active members. The meetings are held weekly

with all students attending as a curriculum requirement. High honors have been won in the all-campus festival.

Missouri School of Mines This Branch is known as the Orton Society. Two meetings are held each month. The senior class attended the Annual Meeting of the Society.

University of North Carolina There are twenty active and eight associate members. The programs are generally furnished by members of the faculty and the attendance at meetings has shown a definite increase. The senior class attended the Annual Meeting.

Ohio State University This Branch is carrying on a definite drive to increase its membership, reported at twenty. Speakers are obtained from the faculty and outside. The average attendance at meetings is thirty. Eleven student members attended the Annual Meeting.

Pennsylvania State College There are nineteen regular members of this Branch. The meetings are held monthly with faculty and outside speakers. One meeting was held under the auspices of the School of Mineral Industries and the Pittsburgh Section. Several seniors attended the Annual Meeting.

Rutgers University This Branch has an active membership of twenty. Representative speakers from various branches of the industry are secured and the spring meeting is devoted to ceramic art; the public is invited. Social affairs are apparently stressed.

University of Illinois This Branch charges a fee of 25 cents per semester. The meetings are monthly, usually at the Ceramic Building, but frequently take the form of smokers at various fraternity houses. Faculty and outside speakers are invited.

Summary There are eight active Student Branches; one more is in the process of reorganization. Interest and activity seem to be good.

The Committee feels that the Student Branches should be definitely cultivated for the good of the students and the future of the Society. To this end, the Committee has tried to determine what the Society might do to make the Annual Meeting more attractive to the students who attend. Suggestions coming from the students themselves indicate that while they enjoy the general sessions of the Society and such social opportunities as are offered, they would appreciate some opportunity to hold a session of their own. The president of one Student Branch has suggested that there might be an organization of Student Branches throughout the country and that a session at the Annual Meeting should be arranged so that they could discuss special problems of interest to themselves, these arrangements being made by the organization of Student Branches.

It is the opinion of the Chairman of this Committee that a definite effort should be made to contact the Student Branches during the year by personal visits from officers or trustees of the Society. With some planning this work could be carried out without major expense.

Divisions

No matters relating to the Divisions of the Society have come to the attention of this Committee. The only "problem" Division, the Art Division, was referred to L. E. Barringer and it was not thought necessary to interfere with what is being done. Mr. Barringer studied this problem carefully and arranged a program under the auspices of the Art Division for the General Session of the Society on Monday, February 12, 1934. The Division met on Wednesday to discuss the fundamentals of its activities. This Committee feels certain that Mr. Barringer's leadership will point the way for the Art Division.

In general, it is felt that the functions of the Committee on Sections and Divisions are very important. The major problems probably involve the Local Sections and Student Branches as means of maintaining present and establishing future interest in the Society with particular reference to those who are unable to attend the Annual Meetings. The Committee realizes that present financial conditions do not permit extensive local expenditures or the spending of money from the treasury of the Society. In spite of these limitations, careful planning and encouragement should produce beneficial results and pave the way for greater activities when conditions warrant.

EMERSON P. POSTE, *Chairman*

GLASS TRANSLATION SERVICE PROVES VALUABLE

Last year, through the efforts of members of the Glass Division, the American Ceramic Society offered to its members translations of articles on glass from foreign (chiefly German) publications. These translations, complete with illustrations of some of the articles, were furnished to forty-nine subscribers in mimeographed sheets at a cost of $5.00 each year.

There are four more translations, the fifteenth to eighteenth inclusive, yet to be sent out. This will make a total of eighteen translations (137 pages) for those who subscribed for 1933.

This translation service of the Glass Division will not be continued another year. The members of the Glass Division will be adequately cared for under a new arrangement which is being made by *Glass Industry*, which will feature three or four pages of translation summaries of the German literature by S. R. Scholes, Professor of Glass Technology at New York State College of Ceramics, Alfred, N. Y. Inquiries may be addressed to the American Ceramic Society offices or to F. C. Flint, Hazel-Atlas Glass Company, Washington, Pa.

DR. SILVERMAN IN SPAIN

Alexander Silverman, Head of the Department of Chemistry, University of Pittsburgh, was one of six councillors representing the National Academy of Science and the National Research Council at the 11th Conference of the International Union of Chemistry held in Madrid, Spain, April 5–11, 1934.

The International Union is, as the term implies, a clearing house for chemistry and for the establishment of international standards. Meetings are held every other year in a different country and each nation is entitled to a certain number of delegates. Those holding the title of councillor have a voting power at the official sessions.

Dr. Silverman was also a delegate of The American Ceramic Society to the 9th International Congress of Pure and Applied Chemistry, which met in Madrid during the same week. At the latter meeting he presented a preliminary report on "Causes of Opalescence in Glass," which was prepared jointly with H. H. Blau of the Macbeth-Evans Glass Company.

Dr. Silverman was a delegate from the Research Council and the American Ceramic Society to the international meetings that were held in Liège, Belgium, in the fall of 1930. He sailed March 24 on the Ile de France and will return from Havre, France, April 18 on the Paris. Dr. Silverman also expects to spend some time in France visiting educational institutions and museums there as well as in Spain.

ROSTER CHANGES*

CORPORATION

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Murgatroyd, John B., Rockware Glass Syndicate, Ltd., 142–43 Audrey House, Ely Place, London, E. C. 1, England. (British Hartford Fairmont, Ltd., Greenford, England.)

Parsons, Joseph R., Chicago Fire Brick Co., 7531 S. Ashland Ave., Chicago, Ill. (724 Buncombe St., Hendersonville, N. C.)

Peterson, Fred W., American Enameled Brick & Tile Co., South River, N. J. (437 Rhoads Ave., Columbus, Ohio.)

Potts, Amos P., 118 E. Blaine, Brazil, Ind. (Alliance Brick Co., Darlington, Pa.)

Randall, J. E., 414 E. Fall Creek Blvd., Indianapolis, Ind. (*Clay-Worker*, Indianapolis, Ind.)

Robertson, F. H., Claycraft Potteries, 3101 San Fernando Rd., Los Angeles, Calif. (1700 Grand View, Glendale, Calif.)

Russell, Ralston, Jr., Y. M. C. A., Flint, Mich. (Pomeroy, Ohio.)

Seabright, Edward C., Electromaster, Inc., 1803 E. Atwater St., Detroit, Mich. (Ferro Enamel Corp., Cleveland, Ohio.)

Singer, Felix, Keramos House, 31 Croham Park Ave., South Croydon, Surrey, England. (Berlin-Grunewald, Germany.)

Stoin, S. M., R. F. D., Dalton, Ohio. (Crooksville, Ohio.)

Stolz, René, Niederbronn-les-Bains, 1 Rue de la Fonderie, Bas-Rhin, France. (9 Rue Lenau, Strasbourg, France.)

Strong, Kenneth B., 7611 Oglesby Ave., Chicago, Ill. (618 North 62nd St., Wauwatosa, Wis.)

Thornton, Paul E., 1430 Hyde Park Blvd., Chicago, Ill. (428 Argyle St., Waterloo, Iowa.)

* The address within parentheses represents the old address.

COLONEL HOSTETTER HONORED BY KENTUCKY GOVERNOR

Governor Ruby Lafoon of Kentucky is making his name known throughout the country by conferring the honorary title of "Colonel" upon famous visitors to his State.

Among his most recent "Colonels" is John Clyde Hostetter, president of the American Ceramic Society, 1933–1934. The commission was conferred as a part of the program of the informal "Ruckus" held during the Cincinnati Meeting, February 12, 1934.

Warner Sayers, acting as Governor Lafoon's representative, presented Dr. Hostetter with the commission. Following the presentation speech a glass sword, a tribute from the American Ceramic Society, was presented to the Colonel by Secretary Ross C. Purdy.

Made of the new Steuben rock crystal glass, with a gold-ruby glass hilt, the sword has engraved on it:

Presented to
Col. John Clyde Hostetter
By American Ceramic
Society

On the mahogany case, especially made to hold this "weapon," is a glass plate bearing Colonel Hostetter's name.

A sword used in overseas service by Major W. H. Curtiss, vice-president of Corning Glass works, provided a model for the Steuben Division of the Corning Glass Works designers. To James Janson, the master craftsman, and his assistants belongs the credit for making entirely by hand this beautiful tribute in glass to their former chief, who is now Director of Development and Research at Corning Glass Works.

The "Ruckus" thus proved to be an evening of surprises, for the commission and the sword surprised Colonel Hostetter as completely as the presentation of the Oldsmobile "8" amazed Ross C. Purdy.

Various members of the Society who were present at the "Ruckus" have expressed deep regret over the fact that space does not permit the inclusion here of the now famous story of how the Colonel-creating Governor of Kentucky got his name.

LOCAL SECTION NEWS

Pittsburgh Section[1]

On March 13, at Mellon Institute, Henry Leighton, Head of the Department of Geology of the University of Pittsburgh, addressed the Pittsburgh Section on the subject of "The Refractory White Clays of Pennsylvania." These clays are in scattered pockets in two groups, one in the central part of the state, the other in the eastern. While the deposits have had a desultory commercial development, they are interesting as being examples of kaolin formed from the disintegration of sedimentary rocks and not from igneous rocks, as is usually the case. No white ware has ever been made from these clays, but they have found application in the manufacture of rubber, linoleum, paper, Portland cement, and refractory cements.

Discussion of the paper was continued at the meeting of the Pittsburgh Clayworkers Club which was held at a later hour of the same evening.

Following the paper, Thomas N. Kurtz described the highly aluminous nodular clays of the state, but pointed out that these differed from the white clays in that they were all coal age formations.

W. Keith McAfee, President of the American Ceramic Society told the members of the plans of the Society for the coming year.

HOW THE ANNUAL MEETING REGISTRATION FEE WAS USED

Income		
Registration	$1133.15	
Luncheon tickets	320.00	
Total Income		$1453.15
Expenses		
Printing Programs	183.85	
Printing card announcements	18.50	
Paper and stencils	7.85	
Badges	45.44	
250 *Bulletins*	45.00	
Postage and postcards	192.44	
Express charges	6.21	
Railroad expense	65.00	
Shorthand reporter	32.36	
James Coleman, picture machines	103.50	
Operators for picture machines	71.00	
Speakers' expense	63.29	
Office staff expenses	204.14	
General luncheon	180.00	
Glass Division luncheon	98.00	
Refractories Division luncheon	50.00	
Signs	38.00	
Tips	38.50	
Glass blowing fixtures	10.07	
Preprints	60.00	
Miscellaneous	175.00	
Total Expenses		$1688.15
Expense over Income		235.00

[1] Robert F. Ferguson, *Secretary*.

NEW MEMBERS RECEIVED IN MARCH

Corporation

Jova Brick Works, J. L. Jova (voter), Roseton, N. Y.

Personal

James Bailey, 79 Central Ave., Hamburg, N. Y.; Vice-President, Bailey & Sharp Co.

Woo Chen-Tung, Taishan Brick & Tile Co., Loonghua, Shanghai, China.

Kurt Dehne, Königsweg, 30, Berlin-Charlottenburg, Germany.

Herbert George Fry, 3 Ravensbourne Park Crescent, Catford, London S. E. 6, England; National Enamels, Ltd.

Jack Mayer, Bethlehem Steel Co., Bethlehem, Pa.

G. H. McIntyre, Research Chemist, Ferro Enamel Corp., 4150 East 56th St., Cleveland, Ohio.

'Asgeir Riis, Robeson Process Co., 230 Park Ave., New York, N. Y.

Herbert S. Schroeder, 202 Eightieth St., Niagara Falls, N. Y.; Research Chemist, Carborundum Co.

Student

H. G. Burlingame, Ohio State University.

Charles Jacob Koenig, Ohio State University.

Robert P. Stevens, University of Illinois.

Membership Renewal

F. J. Kennedy, West Gas Improvement Co., Inc., 441 Lexington Ave., New York, N. Y.

Membership Workers' Record

Personal		Corporation	
G. J. Easter	1	J. C. Hostetter	1
J. E. Hansen	1		
P. D. Helser	1	Student	
Kai-Ching Lu	1	R. K. Hursh	1
D. E. Sharp	1	A. J. Metzger	2
Office	3		
	–	Total	3
Total	8	Grand Total	12

TECHNICAL ASSOCIATION OFFERS MEMBERSHIP ADVANTAGES TO MEMBERS OF THE AMERICAN CERAMIC SOCIETY

The American Association for the Advancement of Science, Henry B. Ward, Permanent Secretary, has asked that an announcement be made of the special membership offer by their Association to members of the American Ceramic Society. By virtue of the fact that the American Ceramic Society is affiliated with the A.A.A.S., members may join the latter Association by payment of annual dues only. The usual entrance fee of $5 is waived in cases of members of affiliated societies. The offices of the permanent secretary are in the Smithsonian Institution Building, Washington, D. C.

NECROLOGY

DAVID RAYMOND EDGAR

David Raymond Edgar, president of Edgar Brothers Co. and Edgar Plastic Kaolin Co., Metuchen, N. J., prominently known in the American clay-mining industry, died suddenly of a heart attack at his residence at Metuchen, February 28, aged 51 years. He had enjoyed only fair health for a number of months past, and had been forced to limit his hours of business because of a heart ailment. Mr. Edgar was born at Metuchen, the son of Mr. and Mrs. I. R. Edgar, and the greater part of his life was spent in that community, where in addition to his business interests he was prominent in civic activities.

DAVID R. EDGAR

Mr. Edgar was graduated in 1903 from Rutgers University, New Brunswick, and was a member of the Beta Theta Pi fraternity and trustee of the New Brunswick Theological Seminary. He took special training while in college which fitted him admirably as a business executive and for his future work in the ceramic industry. Following his graduation, he became associated with his uncle, Charles S. Edgar, founder of the Edgar Companies and a pioneer in the American clay-mining industry. With his uncle, Mr. Edgar spent many of his early years in Georgia and Florida where the famous Edgar clay mines are located, becoming thoroughly familiar with the mining, refining, and shipment of clays. Following the death of his uncle and his father, who also was associated in the business, he became president of the Edgar companies; under his able direction and foresight the business has grown to large proportions in the furnishing of clays for the ceramic, paper, and other industries. Mr. Edgar is survived by his widow and two sons, Donald and Richard Edgar, and by his brother, Harold T. Edgar, also of Metuchen and prominently identified with the Edgar business as treasurer of the company.

Mr. Edgar had been a personal member of the American Ceramic Society since 1908, his Company has held a corporation membership for years, and a number of the men associated with him in the Edgar Plastic Kaolin Co. have been among the faithful workers of the Society. The Society has lost a good friend in the death of David Raymond Edgar.

AMERICAN POTTERY AND PORCELAIN DISPLAY SPONSORED BY THE IOWA FEDERATED WOMEN'S CLUBS

American Ceramic Manufacturers Asked to Assist

In connection with the spring conference of the Iowa Federated Women's Clubs a display was held of American-made pottery and porcelain from the loan collection of the Department of Fine Arts of the Iowa Federation. The exhibit was held at Younkers Department Store in Des Moines, Iowa. Paul E. Cox, head of the Department of Ceramic Engineering at Iowa State College, sends the following information concerning the exhibit.

The Iowa Federation of Women's Clubs has had this collection of pottery which includes American earthenware, hotel china, belleeks, some glass and art pottery products, together with an educational exhibit covering the manufacturing processes to some extent. This show is split in two parts, but will be assembled for the Des Moines gathering of the members of the local boards from all of the clubs of Iowa.

Little of the showing is Iowa-produced. Much of it is from Ohio and New Jersey. These club women do certainly spread the gospel of ceramic ware for the home. The show is by no means a high class one. The manufacturers should make their best efforts to supply Mrs. Dixon with photographs, films, descriptive matter, and, above all, with the very best things in technique and design that they produce. This showing in Des Moines drew about two thousand people and it cost the manufacturers very little. I answer on the average of three letters a week the year around which results from these showings of American pottery. We are not so strong on research out here, but we are working on the sales end anyhow.

Professor Cox gave a talk before the Federation on March 8, and later gave talks before students from the Des Moines schools, of Drake University, and from the Smouse School, the Opportunity School of Des Moines.

Manufacturers who wish to add a showing of their ware to this exhibit should write to Mrs. J. W. Dixon of Burlington, Iowa, or to Professor Cox.

Showings of this kind are sponsored by representatives of the Art Division of the American Ceramic Society and they are receiving every possible encouragement from the Society. It is a gratifying sign that, in this period when foreign-made ware is receiving so much attention from American buyers, groups of women buyers in such organizations as this in Iowa are concentrating their interests and efforts upon American-made ware.

Massachusetts Institute of Technology Notes

E. W. Harmon, a graduate in chemical engineering of the Massachusetts Institute of Technology, has been appointed assistant in ceramics. This addition to the staff was necessary because of the considerable increase in enrollment in the ceramic courses this term.

During the last few months there have been a number of important additions made to the ceramic museum, both of contemporary ware of American manufacture and historic pieces from New England. It is hoped eventually to have representative pieces to illustrate all phases in the development of pottery and glass as well as the modern trends. There also has been acquired a number of small pieces of ceramic sculpture.

MRS. ORTON ORGANIZES POTTERY GROUP

During the month of February, 1934, through the continued efforts of Mrs. Edward Orton, Jr., a pottery group was organized in the Fine Arts group of the Columbus chapter of the American Association of University Women. There are nine women in this group, meeting two mornings each week, and working under the direction of Ralph Trivella, director of the Little Gallery in Columbus. The class meets at the Columbus Art Gallery and the enthusiasm of its members as well as the excellent standard shown in the work in the short time since its organization has caused the Columbus Art Gallery directors to offer financial assistance to promote this work.

Mrs. Orton is to be congratulated for her earnest efforts in this work and for its success which, in another year, promises to develop rich and gratifying results in ceramic pottery and art work.

ANNUAL ENAMELING SCHOOL

The Ferro Enamel Corporation, Cleveland, Ohio, announces it will hold its annual course of study for porcelain enamelers on May 3, 4, and 5 in Cleveland, Ohio. The course will be open to members of the porcelain enameling, steel, and other allied industries. A series of lectures will be given with discussions by the members of the classes to follow. Complete announcement will be made later and booklets will be available.

MEETINGS OF THE OHIO CERAMIC INDUSTRIES ASSOCIATION

White wares Division, May 22 and Heavy Clay Products Division, May 25

Announcement is made of a joint meeting of the White Wares Division, Ohio Ceramic Industries Association, Pittsburgh Section, American Ceramic Society, and the Ceramic Engineers Club of East Liverpool. The meeting will be held May 22 at New Castle, Pa. The program will appear in the May issue of *The Bulletin*.

On Friday, May 25, the members of the Heavy Clay Products Division, Ohio Ceramic Industries Association, will hold a meeting at the Shady Hollow Country Club, Massillon, Ohio.

A. V. HENRY, PRESIDENT OF THE GEORGIA ACADEMY OF SCIENCE

Arthur Van Henry, head of the Department of Ceramic Engineering, Georgia School of Technology, Atlanta, Ga., has been elected president of the Georgia Academy of Science.

The Academy has for its major purpose the promotion of science, particularly in Georgia. It is a closed organization consisting of ninety-five members, each being elected upon the recommendation and nomination of the group. The meeting for 1934 was held in Atlanta, Ga., at which time five divisions of the Academy met simultaneously with the public invited.

ARTHUR E. BAGGS HONORED AT THE ANNUAL EXHIBITION OF THE COLUMBUS ART LEAGUE, MARCH, 1934

Last year at the Annual Exhibition of the Columbus Art League, Mrs. Edward Orton, Jr., offered for the first time the Edward Orton, Jr. prizes for the best work in ceramic sculpture, pottery, and ceramic design. These prizes were awarded this year to Chester Nicodemus, Herbert Sanders, and Richard Huebner. Although Arthur E. Baggs, head of the ceramic art work in the Department of Fine Arts, Ohio State University, did not compete for the prizes in this exhibit, the Exhibit Jury gave him honorable mention for "maintained excellence of work." Other members of the Art Division of the American Ceramic Society exhibiting were Paul Bogatay and Edgar Littlefield.

ANNUAL MINERAL INDUSTRIES CONFERENCE OF ILLINOIS

The second annual Mineral Industries Conference of Illinois was held at Urbana, Illinois, on March 15 to 17, 1934. "Home Building in Illinois" was the main topic of discussion and the purposes of the conference were outlined as follows: (1) to explore the possibilities of providing better and lower-priced homes, (2) to acquaint the manufacturers of building materials with the home owner's viewpoint in what he desires in a home, (3) to bring to the attention of present and prospective owners, builders, and manufacturers, the mineral resources of Illinois available for home building, and (4) to ascertain the researches needed to improve and further the use of mineral substances for modern homes.

The Conference was sponsored by the Illinois State Geological Survey, of which M. M. Leighton is chief, the Colleges of Agriculture, Engineering, and Fine and Applied Arts of the University of Illinois in coöperation with the American Ceramic Society, and twenty-one other national and state organizations of allied interests.

Eben Rodgers, president of the Alton Brick Company, Alton, Illinois, presided at the Friday morning session when Hugo Filippi presented a paper on "Reinforced Brick Masonry in Residence Construction." At the first session C. W. Parmelee, head of the Department of Ceramic Engineering, presented a joint paper with M. M. Leighton, on "Mineral Construction Resources and Products of Illinois." The final session on "Needed Researches" was presided over by Arthur Cutts Willard, acting dean of the College of Engineering, and acting director of the Engineering Experiment Station, University of Illinois.

The following program of papers and research discussions was presented:

(1) "Clays and Shales," by Ralph E. Grim, Illinois State Geological Survey, (2) "Ceramic Products," by C. W. Parmelee, (3) "Insulating Materials," by F. H. Reed, chief chemist of the Illinois State Geological Survey, (4) "Research in Sound Insulation," by F. R. Watson, professor of experimental physics, College of Engineering, (5) "Research in Heating, Ventilating, and Air-Conditioning," by A. C. Willard and A. P. Kratz, and (6) "Desirable Investigations in the Use of Illinois Coals for Domestic Purposes," by A. C. Callen, professor of mining engineering, and head of Department of Mining Engineering.

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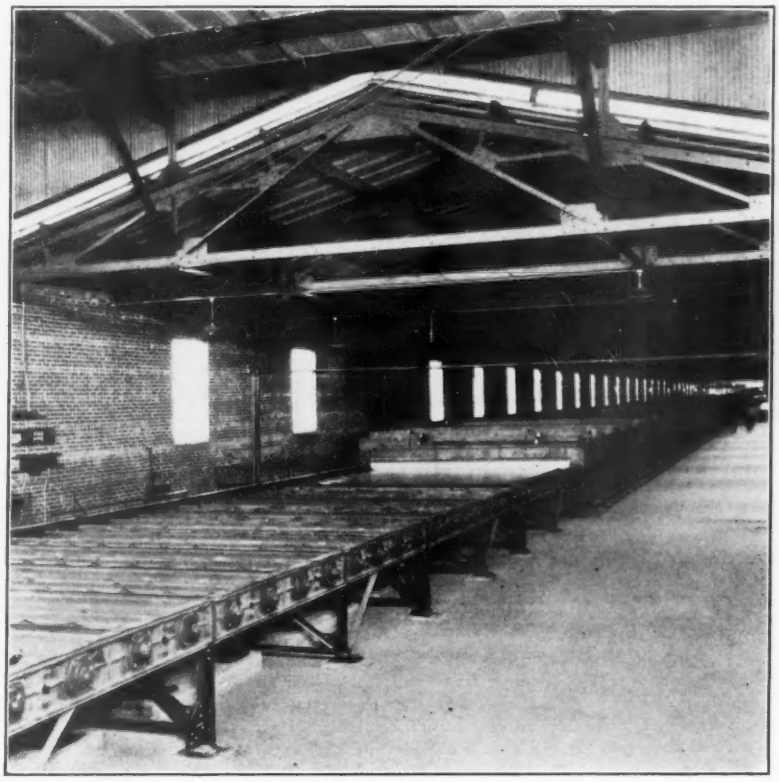

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Cadmium Sulphide
Chrome Oxide Green
Clay Vallendar
Cobalt Oxide Black
Cobalt Sulphate
Copper Oxides
Epsom Salts
Iron Chromate
Iron Oxides
Lead Chromate
Magnesium Carbonate
Manganese Dioxide
Nickel Oxides
Gray, Black
Potassium Bichromate
Powder Blue
Rutile Powdered
Sodium Antimonate
Selenium
Sodium Bichromate
Sodium Silicate
Sodium Silico Fluoride
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Titanium Oxide
Uranium Oxide Orange
Uranium Oxide Yellow
Zinc Oxides
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A

Abrasives (Alundum-Crystolon)
Norton Co.

Aloxite (Refractory Products)
Carborundum Co.

Alumina (Hydrate and Calcined)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Aluminum Oxide (Fused)
The Exolon Co.
The Vitro Mfg. Co.

Alundum (Refractory Products)
Norton Co.

Ammonium Bifluoride
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Ammonium Carbonate
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Antimony Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

B

Ball Mills
McDanel Refractory Porcelain Co.

Ball Mills (Laboratory Type)
Ceramic Color & Chemical Mfg. Co.

Barium Carbonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hammill & Gillespie, Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Batts
Carborundum Co. (*"Carbofrax Aloxite"*)
Norton Co. (*Alundum Crystolon*)

Bitstone
Potters Supply Co.

Blocks (Refractory)
Carborundum Co.
Norton Co.

Borax
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Borax Glass
Pacific Coast Borax Co.

Boric Acid (Anhydrous)
Pacific Coast Borax Co.
The Vitro Mfg. Co.

Boric Acid (Crystal, Granular, or Powder)
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Bricks (Refractory)
Carborundum Co. (*"Carbofrax Aloxite"*)
Norton Co.

C

Carbofrax (Refractory Products)
Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

Carbonates (Barium, Lead)
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Caustic Soda
Ceramic Color & Chemical Mfg. Co.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Cements
Carborundum Co.

Ceramic Chemicals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Chromium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Clay (Ball)
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
The Roessler & Hasslacher Chemical Co.
Spinks Clay Co., H. C.
The Vitro Mfg. Co.

Clay (China)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Edgar Brothers Co.
Hammill & Gillespie, Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Clay (Electrical, Porcelain)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Hammill & Gillespie, Inc.
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.
The Vitro Mfg. Co.

Clay (Enamel)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Hammill & Gillespie, Inc.
Kentucky-Tennessee Clay Co.
Metal & Thermit Corp.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.

Clay (German Vallendar)
Ferro Enamel Corp.
Hammill & Gillespie, Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Clay Miners
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay (Potters)
Hammill & Gillespie, Inc.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay (Sagger)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wad)
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wall Tile)
Hammill & Gillespie, Inc.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clocks (Gauge Board)
Ferro Enamel Corp.

Cobalt Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Colors
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Cornwall Stone (Imported)
Hammill & Gillespie, Inc.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Crucibles (Filter, Melting, Ignition)
Norton Co.
Potters Supply Co.

Crystolon (Refractory Products)
Norton Co.

D

Decorating Supplies
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Drying Machinery
Ferro Enamel Corp.

E

Enameling Equipment (Complete)
Chicago Vitreous Enamel Products Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

Enameling Furnaces
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Norton Co.
Porcelain Enamel & Mfg. Co.

Enameling Iron (Sheet)
American Rolling Mill Co.

Enameling Muffles
Carborundum Co. (*Carbofrax*)
Norton Co. (*Alundum*)

Enameling (Practical Service)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.
Titanium Alloy Mfg. Co.

Enamels
Ceramic Color & Chemical Mfg. Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Enamels (Porcelain)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.
Titanium Alloy Mfg. Co.

Equipment (Porcelain Enameling)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

Exolon (Refractory Products)
The Exolon Co.

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F

Feldspar
Ceramic Color & Chemical Mfg. Co.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Fire Brick
Carborundum Co.
Norton Co.

Flint
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Flint Pebbles
Ferro Enamel Corp.

Floors (Non-Slip)
Norton Co.

French Flint
Paper Makers Importing Co.

Frit
Ceramic Color & Chemical Mfg. Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.
Titanium Alloy Mfg. Co.

Furnace
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

G

Glaze and Body Spar
Ceramic Color & Chemical Mfg. Co.
Paper Makers Importing Co.
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Ferro Enamel Corp.
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Titanium Alloy Mfg. Co.

Glaze Spar
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Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Gold
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Grinding Wheels
Norton Co. (*Alundum Crystolon*)

H

Hearths
Carborundum Co.
(*Carbofrax* heat treating)
Norton Co. (*Crystolon*)

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
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Norton Co.

I

Iron (Enameling)
American Rolling Mill Co.

K

Kaolin
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Hammill & Gillespie, Inc.
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The Vitro Mfg. Co.

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Drakenfeld & Co., B. F.

Kryolith
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

L

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Norton Co.

M

Magnesia (Sintered, Calcined)
The Exolon Co.
Norton Co.

Magnesite
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hammill & Gillespie, Inc.
The Roessler & Hasslacher Chemical Co.
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Manganese
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hammill & Gillespie, Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Metals (Porcelain Enameling)
American Rolling Mill Co.

Minerals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
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Ferro Enamel Corp.
Carborundum Co. (*Carbofrax*)
Norton Co.

Mullite (Artificial)
The Exolon Co.

Muriatic Acid
Pennsylvania Salt Mfg. Co.

N

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

O

Opacifiers
Ceramic Color & Chemical Mfg. Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Oxides
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Ferro Enamel Corp.
Metal & Thermit Corp.
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P

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The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
McDanel Refractory Porcelain Co.

R

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The Exolon Co.
Norton Co.

Refractory Materials
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The Exolon Co.
Norton Co.
Titanium Alloy Mfg. Co.

Rutile
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Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

S

Saggers
Carborundum Co.
Norton Co.
Potters Supply Co.

Selenite of Sodium
Drakenfeld & Co., B. F.
The Vitro Mfg. Co.

Selenium
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Sheets (Enameling Iron)
American Rolling Mill Co.

Silica (Fused)
The Exolon Co.

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Ceramic Color & Chemical Mfg. Co.
Philadelphia Quartz Co.
The Vitro Mfg. Co.

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The Exolon Co.
Norton Co.

Silicon Carbide Firesand
The Exolon Co.

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The Exolon Co.

Slabs (Furnace)
Carborundum Co.
Norton Co.

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Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

Soda Ash
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The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Sodium Fluoride
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Spar
Ceramic Color & Chemical Mfg. Co.
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The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Spurs
Potters Supply Co.

Stilts
Potters Supply Co.

Sulphuric Acid
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Pennsylvania Salt Mfg. Co.

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Talc
Hammill & Gillespie, Inc.
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Tanks (Pickle)
Ferro Enamel Corp.

Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Norton Co.

Tile (Wall)
Ferro Enamel Corp.

Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Vitro Mfg. Co.
Titanium Alloy Mfg. Co.

Titanium Oxide
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.
Titanium Alloy Mfg. Co.

Tubes (Insulating)
McDanel Refractory Porcelain Co.
Norton Co.

Tubes (Pyrometer)
McDanel Refractory Porcelain Co.
Norton Co.

W

Wet Enamel
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Whiting
Drakenfeld & Co., B. F.
Hammill & Gillespie, Inc.
Paper Makers Importing Co.
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Z

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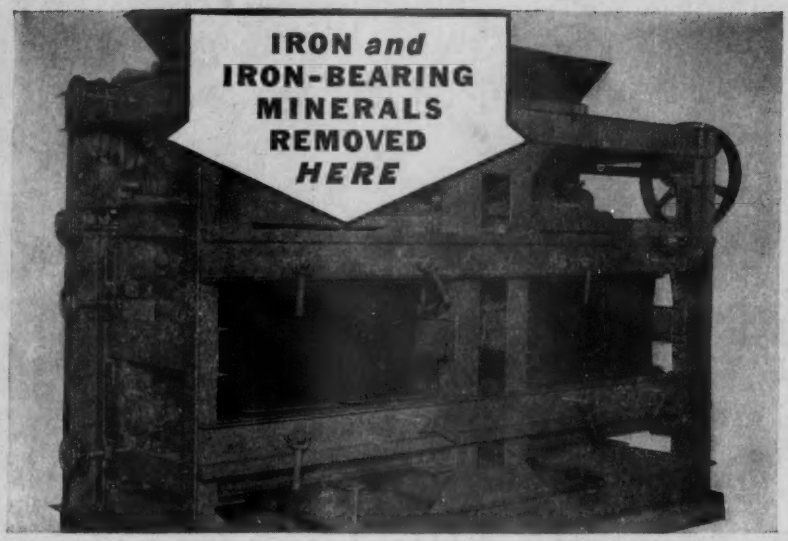

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